Analysis of the Efficiency Gaps of Wisconsin's Current Legislative District Plan and Plaintiffs' Demonstration Plan

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I. Introduction

My name is Kenneth Mayer and I currently am a Professor of Political Science at the University of Wisconsin-Madison, and a faculty affiliate at the Lafollette School of Public Affairs, at the University. I joined the faculty in 1989. I teach courses on American politics, the presidency, Congress, campaign finance, election law, and electoral systems.

I have been retained by counsel representing the plaintiffs in this lawsuit (the "Plaintiffs") to analyze and provide expert opinions. I have been asked to determine whether, in my opinion, it is possible to create a Wisconsin state legislative map that does not result in systemic partisan advantage, by drawing a legislative district plan that has an efficiency gap as close to zero as possible while complying with federal and state requirements at least as well as the plan enacted by the Wisconsin legislature in Act 43.[1]

I submit this report, which contains the opinions that I intend to give in this matter. I describe my methods for estimating the state Assembly vote in actual and hypothetical state legislative redistricting plans, and for calculating the efficiency gap for Act 43 and for the alternative demonstration plan I drew.

My opinions, which are based on the technical and specialized knowledge that I have gained from my education, training and experience, are premised on commonly used, widely accepted and reliable methods of analysis, the application of the legal requirements of redistricting, and are based on my review and analysis of the following information and materials:

- Redistricting materials available from the Wisconsin legislature at http://legis.wisconsin.gov/gis/data, including Geographic Information System (GIS)

[1] The federal requirements are equal population, compliance with Section 2 of the Voting Rights Act, and the ban on racially gerrymandered districts. The state requirements are contiguity, compactness, and respect for political subdivisions (counties, towns, cities, and villages).

files for Act 43 districts, and ward level election data for 2012

- Census Bureau data on population, citizenship, and location of institutionalized populations as explained below
- Election data from the 2013-2014 Wisconsin *Blue Book* for the 2012 State Assembly and presidential elections
- Election data from the Government Accountability Board, including ward level 2012 election results for State Assembly and presidential elections.
- GIS data, including Census population figures, block assignments, and shape files for Wisconsin, available in the GIS program Maptitude for Redistricting
- Files submitted by defendants in *Baldus et al. v. Brennan et al.*

I conducted my analysis using Stata, Excel, R, and Maptitude for Redistricting.

II. Qualifications, Publications, Testimony, and Compensation

I have a Ph.D. in political science from Yale University, where my graduate training included courses in econometrics and statistics. My undergraduate degree is from the University of California, San Diego, where I majored in political science and minored in applied mathematics. My curriculum vitae is attached to this report as Exhibit 1.

All publications that I have authored and published in the past ten years appear in my curriculum vitae, attached as Exhibit 1. Those publications include the following peer-reviewed journals: Journal of Politics, American Journal of Political Science, Election Law Journal, Legislative Studies Quarterly, Presidential Studies Quarterly, American Politics Research, Congress and the Presidency, Public Administration Review, and PS: Political Science and Politics. I have also published in law reviews, including the Richmond Law Review, the UCLA Pacific Basin Law Journal, and the University of Utah Law Review. My work on campaign finance has been published in Legislative Studies Quarterly, Regulation,

PS: Political Science and Politics, Richmond Law Review, the Democratic Audit of Australia, and in an edited volume on electoral competitiveness published by the Brookings Institution Press. My research on campaign finance has been cited by the Government Accountability Office, and by legislative research offices in Connecticut and Wisconsin.

My work on election administration has been published in the Election Law Journal, American Journal of Political Science, Public Administration Review, and American Politics Research. I was part of a research group retained as a consultant by the Wisconsin Government Accountability Board to review their compliance with federal mandates and reporting systems, and to survey local election officials throughout the state. I serve on the Steering Committee of the Wisconsin Elections Research Center, a unit with the UW-Madison College of Letters and Science. In 2012 I was retained by the U.S. Department of Justice to analyze data and methods regarding Florida's efforts to identify and remove claimed ineligible noncitizens from the statewide file of registered voters.

In the past eight years, I have testified as an expert witness in trial or deposition in the following cases: *Baldus et al. v. Brennan et al.,* 849 F. Supp. 2d 840 (E.D. Wis. 2012); *Milwaukee Branch of the NAACP et al. v. Walker et al.,* 2014 WI 98, 357 Wis. 2d 469, 851 N.W. 2d 262; *McComish et al. v. Brewer et al.,* No.CV- 08-1550, 2010 WL 2292213 (D. Ariz. June 23, 2010); and *Kenosha County v. City of Kenosha,* No. 11-CV-1813 (Kenosha County Circuit Court, Kenosha, WI, 2011).

I am being compensated at a rate of $300 per hour.

III. Opinions

A. Summary

My opinions may be summarized as follows.

- Using a model that estimates baseline ward-level partisanship, I conclude that the redistricting plan enacted by Act 43 is significantly biased against Democrats, with an efficiency gap of 11.69%. The plan achieves this via the use of classic "packing and cracking" gerrymandering techniques: concentrating Democratic voters into districts where they have overwhelming majorities (packing), and drawing other districts so that Democrats constitute partisan minorities well below 50% and unlikely to win legislative seats (cracking). In doing so, Republicans guarantee a strong majority of legislative seats, even if they obtain well below 50% of the statewide legislative vote. In 2012, Republicans won 61% of State Assembly seats (60 of 99) while achieving only 46.5% of the statewide vote (as measured by the presidential vote, a common proxy for statewide partisanship).

- Using the same measure of partisan strength that the Wisconsin state legislature used in assessing partisan impact of proposed districts in Act 43, Act 43 has an efficiency gap of 12.36%.

- I created a demonstration redistricting plan (the "Demonstration Plan") that is equivalent to Act 43 on population deviation, has fewer political subdivision splits, and has better compactness scores, with a much lower efficiency gap score of 2.20%. This is less than one-fifth of the Act 43 efficiency gap.

- The Demonstration Plan shows that the partisan advantage secured in Act 43 was in no sense required in order to adhere to the constitutional and statutory requirements of legislative redistricting.

B. Measuring Partisanship in Actual and Hypothetical Districting Plans

The efficiency gap is a measure of "wasted votes" that fall into two categories: those votes cast for a losing candidate in a district (lost votes), and votes cast for the winning candidate above what is necessary to win (surplus votes). In an existing set of districts, the calculation is based on the actual vote in each district, with adjustments for uncontested races (Stephanopoulos and McGhee 2015). Larger imbalances in the number of wasted votes signify a degree of partisan unfairness against the political party with more wasted votes.

Calculating the efficiency gap in the Demonstration Plan requires estimating what the underlying partisan vote would be in each newly drawn (and hypothetical) district. The gap cannot be estimated by simply rearranging the votes cast in actual Assembly contests into a new

district configuration, as the votes cast for specific Assembly candidates in each district are a function of the electoral environment in that district and whether a race is even contested by both parties. A large literature has developed around the problem of estimating the likely election results in redistricting plan alternatives and calculating summary statistics that characterize existing and hypothetical plans (Gelman and King 1994; Cain 1985).

In most applications, the partisan consequences of a redistricting plan are expressed in terms of the effect on *future* elections: using prior election results to predict outcomes in subsequent election cycles, or estimating the statewide vote swing required to significantly change the partisan composition of the legislature from one election to the next (Gelman and King 1990; Cain 1985). The results are typically expressed as the estimated two-party vote percentages in each new district (Gelman and King 1994), which are sufficient to forecast who will win an election and calculate swing ratios and seats-votes curves.[2]

My aim is different. Instead of estimating future election results for an existing or proposed hypothetical plan, my goal was to determine whether it was possible to draw a district plan following the 2010 Census that minimized the efficiency gap while maintaining strict fidelity to the federal and state constitutional requirements of population equality, contiguity, compactness, respect for political subdivisions, and compliance with the Voting Rights Act. The efficiency gap is a function of the *number* of wasted votes, and therefore requires a model that generates predictions of *how many votes* would have been cast for Democratic and Republican candidates in 2012 in a different district configuration, rather than simply vote

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[2] Winners are determined by which candidate receives >50% of the vote in a two party race. Seats votes curves depend on the number of seats a party wins in an election (determined by the number of races in which that party received >50% of the vote) and the statewide vote totals in legislative races or some other set of statewide races

percentages. My methods provide a way of estimating what the 2012 Assembly election results would have been in such a Demonstration Plan.

Given appropriate data, it is possible to generate reliable and accurate vote count predictions that can be aggregated to any district boundaries. What is required is a set of independent variables that accurately predict the vote in state Assembly elections but which are to the greatest extent possible *exogenous* to that vote, meaning that the independent variables have underlying values that do not themselves depend on the district vote. If this condition is met, we can estimate what the district vote would have been in an alternative district configuration, since the independent variables do not depend on any particular district configuration. This is not an issue in models that predict future election results, since by definition variables measured today are exogenous to outcomes that occur several years in the future. Because I use one set of election results (the 2012 presidential vote) as part of a model that predicts another set of contemporaneous election results (the 2012 Assembly vote), it is an important but manageable methodological issue.

My method consists of two steps. The first is the construction of a regression model that predicts the 2012 Assembly vote as a function of partisanship, population, demographics, incumbency, and fixed geographic boundaries in Wisconsin's roughly 6,600 wards. In doing so, I establish the empirical relationships between a set of exogenous variables independent of any specific district configurations and the actual Assembly vote in existing wards. In the second step, I use this model to generate a forecast of Assembly vote preferences as a function of these independent variables, and disaggregate this forecast to the Census block level. Using these block level estimates of the Assembly vote, I draw a Demonstration Plan and estimate the Assembly vote and efficiency gap in the resulting districts.

1. Step One: A Model of Voting in Assembly Elections

Estimating the Assembly vote in alternative district configurations requires a model that can generate accurate estimates of the underlying partisanship of a district. As I noted above, the most common models regress the observed Assembly vote on measures of district partisan preferences and other variables known to affect the vote, and generate a predicted value of the vote based on the values of the independent variables. Changing district boundaries will change the values of the independent variables as new voters are moved into the district and others moved out, which in turn allows forecasts of what the vote would be in those new districts.

What I am interested in estimating is *how many* votes will be cast for Democratic and Republican candidates in each district in a demonstration district plan. This involves a different set of variables than is typical in models that evaluate the percentage of votes each party receives, since I require a measure that accounts for both differences in ward populations and variation in turnout.

I use ward level vote totals as the unit of analysis to increase the number of observations available and allow for more precise estimates. Wisconsin's 99 Assembly districts are composed of roughly 6,600 wards, with districts containing between 24 and 153 wards. While the ideal population of an Assembly district is 57,444, wards have an average population of approximately 869 people, and are far more demographically homogeneous.[3]

[3] Legislative Technology Services Bureau data show 6,592 wards in Wisconsin, of which 66 are unpopulated and another 50 have fewer than 10 people. The average populated ward contains 869 people. Wisconsin statutes 5.15 (2)(b) specifies a permissible population range for wards of 300-4,000, depending on a municipality's size, with exceptions allowed in certain circumstances (for example, when single blocks exceed a permitted ward size, or when a municipality is divided into multiple counties or school districts, contains islands, or has wards that must be altered to match district boundaries).

There are four reasons analysis at the ward level is preferable to analysis at the district level. The first is a matter of sheer numbers: the precision of coefficient estimates, forecasting accuracy, and overall statistical power are all strongly related to the number of observations (or sample size). An *n* of 6,600 is far preferable to an *n* of 99, all other things being equal.[4]

The second is the amount of information lost when smaller units are ignored. From a statistical standpoint, using district data when ward data are available imposes the assumption that the values of all of the ward-level variables are equal to the district level variables, when we know this to be untrue immediately upon inspection. Assembly district 1, for example, has 110 populated wards, ranging in population between one and 999 people. In 2012, 73.4% of the voting age population cast ballots in the Assembly contest, and the victorious Republican Assembly candidate received 51.3% of the vote. At the ward level, however, there was considerable variation, with the Republican vote percentage ranging from a low of 38.4% to a high of 75%, and turnout ranging from 50% to over 90%. Ignoring this information and variation will lead to less accurate estimates and forecasts.

Third, in the second step of the analysis I disaggregate ward level estimates to the block level. Minimizing the differences in size and maximizing the homogeneity across that disaggregation will lead to more accurate block level estimates.

And fourth, each Census block is assigned to a single ward,[5] with a unique numerical code that identifies the block's location.[6] These codes allow for disaggregating ward level data

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[4] The larger n also means that OLS is an accurate method of estimating the underlying relationships, whereas more complicated techniques may be required with smaller sample sizes (Afshartous and de Leeuw 2005).

[5] The Census Bureau uses the term "Voting Tabulation District" (VTD). Most states call VTDs precincts. In Wisconsin these units are called "wards."

[6] These are known as FIPS (Federal Information Processing Standard) codes. http://www.census.gov/geo/reference/ansi.html.

into blocks and generating inputs for the redistricting software I use in the second step of my analysis.

I use two main sources of data. The first is redistricting data prepared by the Wisconsin Legislative Technology Services Bureau (LTSB), which consists of spreadsheets with ward level Census population data and election results, as well as ward and district shape files containing this data that can be imported into GIS software.[7] The second source is official election results published by the Government Accountability Board (GAB), both online and in the 2013 edition of the *Wisconsin Blue Book*.

In my experience working with large data sets, and especially when dealing with complex GIS data, I have found data errors to be a common problem. I assessed the reliability of the LTSB data by checking it against the GAB election data, and found numerous errors that required correction, as well some errors that could not be corrected.[8] I describe these errors and my corrections in greater detail in an annex to this report. All subsequent references to ward level vote or population counts uses these corrected vote totals.

The regression model used to predict Assembly vote totals takes the standard form of

$$Y_i = \alpha + \beta X_i + \varepsilon_i,$$

where Y_i is the dependent variable in ward *i*, X_i is a set of independent variables in ward *i,* and α, β, and ε_i are parameters estimated as a function of the variables. The full model is:

$$\mathit{Assembly\ Vote}_i = \alpha + \beta_1 \mathit{Total\ VEP}_i + \beta_2 \mathit{Black\ VEP}_i + \beta_3\ \mathit{Hispanic\ VEP}_i$$

[7] The files are available at http://legis.wisconsin.gov/gis/data. The 2012 election results are in the file Wards_111312_ED_110612.xlsx.
[8] As I note in the Annex, I was not able to allocate 0.21% of the vote in 2012 because of inconsistencies between electoral data reported by the GAB and the geographic redistricting data reported by the LTSB. This small number of votes will not change any of my analysis or conclusions, and such errors are inevitable when working with large data sets.

$$+\beta_4 \begin{array}{c}Democratic\\ Presidential\,Vote_i\end{array} + \beta_5 \begin{array}{c}Republican\\ Presidential\,Vote_i\end{array}$$

$$+\beta_6 \begin{array}{c}Democratic\\ Incumbent_i\end{array} + \beta_7 \begin{array}{c}Republican\\ Incumbent_i\end{array} + \sum_{j=1}^{71} \gamma_j County_j + \varepsilon_i$$

Where

Assembly Vote	Number of votes cast for the Republican or Democratic candidate in the 2012 Assembly election in ward *i*. I estimate separate equations for the Democratic and Republican candidates
Total VEP	Voting eligible population in ward *i*, as measured in the 2010 Census
Black VEP	Voting eligible Black population in ward *i*
Hispanic VEP	Voting eligible Hispanic population in ward *i*
Democratic Presidential Vote	Number of votes cast for Barack Obama in the 2012 presidential election in ward *i*
Republican Presidential Vote	Number of votes cast for Mitt Romney in the 2012 presidential election in ward *i*
Democratic Incumbent	1 if the Assembly election in ward *i* has a Democratic incumbent, 0 otherwise, multiplied by the VEP in ward *i*
Republican Incumbent	1 if the Assembly election in ward *i* has a Republican incumbent, 0 otherwise, multiplied by the VEP in ward *i*
County	Set of fixed effects dummy variables for each county. Dunn County is the excluded value.[9]

The model explains the Assembly vote as a function of four types of variables: district demographics, underlying partisanship, incumbency, and fixed geographic effects.

[9] When using dummy variables (which take binary values of either 0 or 1) to measure effects in units or conditions across the full population, one unit must be excluded, as otherwise perfect collinearity prevents estimation (Greene 1990, 240-241).

a. The Dependent Variable: Ward level Assembly Vote

The key quantity of interest in this analysis is the number of Assembly votes for each party, and it is the dependent variable in the model, using LTSB ward data that I corrected using the process outlined above. Since I am interested in estimating actual vote counts and not the percentage of the two party vote, I estimate separate equations for votes received by each party.[10] Estimating vote counts provides more accuracy than vote percentages, as it controls for variations in turnout across districts.[11]

b. Independent Variables: Demographic Data

The first three independent variables - Total Voting Age Population (VEP), Black VEP, and Hispanic VEP - are the 2010 Census voting age population counts by ward, adjusted to remove ineligible voters.[12] Total VEP constitutes a baseline of the size of the voting population, reflecting the fact that the number of votes will be a function of total population. Black and Hispanic VEP are additional controls that reflect the partisan tendencies of key subpopulations as

[10] The reliance on actual numbers of voters eliminates the Modified Areal Unit Problem, which results when group statistics such as vote percentages or demographic fractions are aggregated into different geographic units levels. All of my variables and measures are scale invariant (see King 1996).

[11] The number of votes cast in Assembly races varies considerably even in in contested races. In 2012, the number of major party votes cast in the highest turnout Assembly election in the 23rd Assembly district, 36,205, was almost twice the number cast in the 90th Assembly district, 18,735, and almost 5 times the number cast in the uncontested 8th district, 7,869 (numbers taken from GAB figures).

[12] The voting eligible population (VEP) adjusts the voting age population by removing adults who are not eligible to vote. In Wisconsin, the two largest categories of ineligible adults that can be identified geographically are noncitizens and adults in prison for felonies. Noncitizens were removed using the 2008-2012 5 year American Community Survey county level noncitizen estimates (available at http://www.census.gov/acs/www/data_documentation/2012_release/. Institutionalized prison populations were identified using Census Bureau "Advanced Group Quarters" files for Wisconsin, available at .http://www2.census.gov/census_2010/02-Advance_Group_Quarters/, and described in http://www.census.gov/newsroom/releases/archives/2010_census/cb11-tps13.html. There are individuals on probation or extended supervision who are also ineligible to vote. I was not able to systematically identify their locations, but they are dispersed enough that they will not have a material effect on my resulting estimates or conclusions. All regression results and district estimates are materially unchanged when the unadjusted data are used.

well as turnout likelihood. Traditionally, both African American and Hispanic populations vote at lower rates that whites, although in 2012 African American turnout was comparable to white turnout. Hispanic populations vote at lower rates than other demographic groups, in part because of a higher noncitizen population, but also because of socioeconomic factors known to reduce turnout.

I expect weak relationships for these measures because of the importance of the next set of variables, which reflect actual voting in the 2012 presidential election.

c. Independent Variables: Measures of Partisanship

The next two variables are the number of votes cast for the Democratic and Republican candidates for president in the 2012 election. The presidential vote is widely used as an exogenous measure of district level partisanship (Ansolabehere, Snyder and Stewart 2000, 2001; Gelman and King 1994; Glazier, Grofman, and Robbins 1987; McDonald 2014; Jacobson 2003, 2009), and it correlates very strongly with other more complex measures of partisan strength (Levendusky, Pope, and Jackman 2008).

The presidential vote is, not surprisingly, an extremely strong predictor of the legislative vote. If we know how many votes were cast for the Republican presidential candidate in a ward we will have a very good idea, subject to some conditions, of how many votes will be cast for the Republican candidate in the legislative election in that ward. While not everyone who votes for the Republican presidential candidate will vote for the Republican state legislative candidate, nearly all will, and we can precisely quantify the nature of that relationship.

The strength of the relationship between presidential and Assembly votes is clear in Figures 1 through 3, which plot the total Assembly vote, Republican Assembly vote, and Democratic Assembly vote in 2012 by the respective presidential vote in each contested ward (where voters have an opportunity to express a preference for either party in the legislative race).

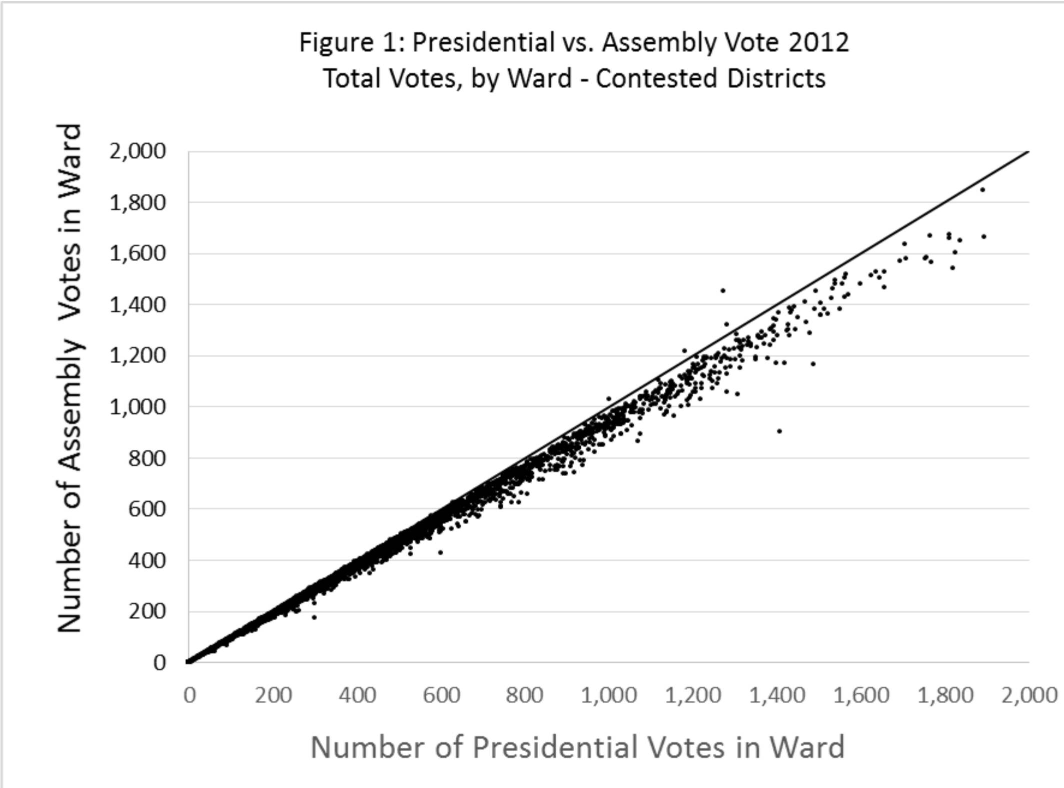
Figure 1: Presidential vs. Assembly Vote 2012
Total Votes, by Ward - Contested Districts
Number of Assembly Votes in Ward
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
Number of Presidential Votes in Ward

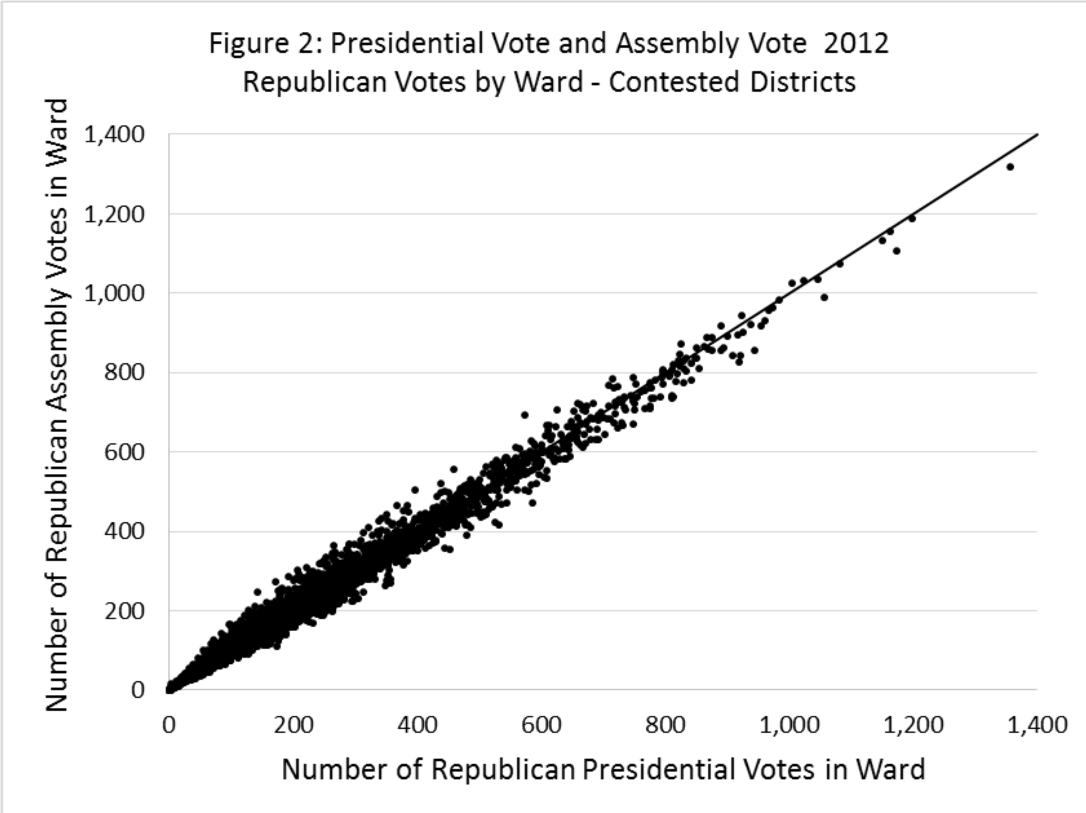
Figure 2: Presidential Vote and Assembly Vote 2012
Republican Votes by Ward - Contested Districts
Number of Republican Assembly Votes in Ward
0
200
400
600
800
1,000
1,200
1,400
Number of Republican Presidential Votes in Ward

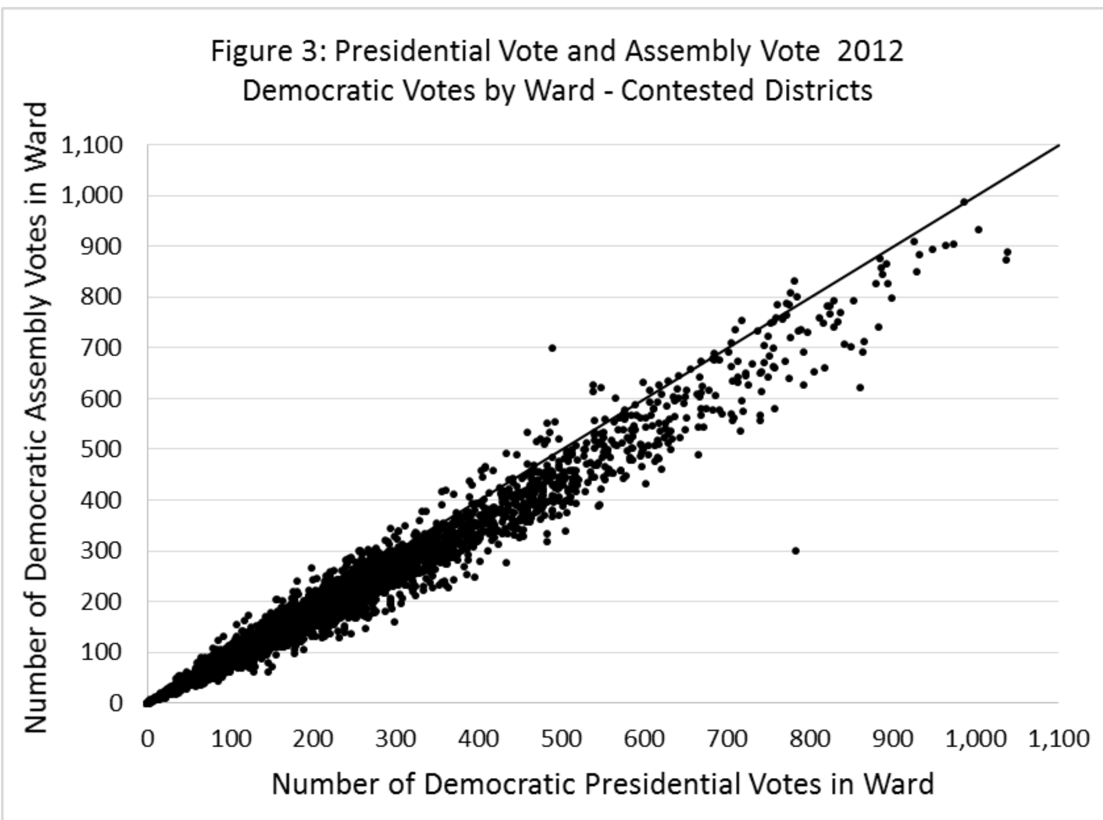
Figure 3: Presidential Vote and Assembly Vote 2012
Democratic Votes by Ward - Contested Districts
Number of Democratic Assembly Votes in Ward
0
100
200
300
400
500
600
700
800
900
1,000
1,100
Number of Democratic Presidential Votes in Ward

Figure 1 shows that the number of presidential votes cast in a ward is very strongly related to the number of Assembly votes, although almost all wards show a "roll off" as some presidential voters opt not to mark the ballot in the assembly race (the reference line shows where the number of presidential and Assembly votes would be equal). Such drop-offs are ubiquitous in down-ticket races, because voters have less information about lower-level candidates and often have weaker or nonexistent preferences (Wattenberg, McAllister, and Salvanto 2000).

The graphs for the Republican (Figure 2) and Democratic (Figure 3) votes show more variance around this reference line, indicating that some voters are splitting their tickets by voting for a presidential candidate of one party and an Assembly candidate of the other. Nevertheless, the relationship between the number the Republican and Democratic presidential and Assembly votes is apparent. Taken together, these figures indicate that the presidential vote is a very strong predictor of the Assembly vote.

An important property of the presidential vote as an independent variable in this model is that it can be treated as exogenous to (i.e., not caused by) the legislative vote. Exogeneity can be described in two ways. The first is in causal terms. Most voters will vote for the same party for the president and state Assembly, as the above graphs show. These voters are consistent because they are Democrats or Republicans, and partisanship is the factor that explains both vote choices. Other voters will make their Assembly choice based on their presidential vote, because they use party labels as a cue when voting in a down-ticket race. "[P]arties are generally known by the presidential candidates they nominate, and candidates for state legislative races are a good deal less well known to voters than the congressional candidates who ride presidential coattails" (Campbell 1986, 46). Few voters, if any at all, will decide on an Assembly candidate first and

then vote for president on the basis of their Assembly vote preference. The causal arrow runs from the presidential vote to the Assembly vote, not from the Assembly vote to the presidential vote. This is why we speak of presidential coattails affecting legislative races, and not the other way around (Campbell 1986; Jacobson 2009).

The second reason why the presidential vote is exogenous to the Assembly vote is that it is not affected by local district-level conditions such as incumbency, spending, or candidate quality (Abramowitz, Alexander, and Gunning 2006, 87). The broader factors that influence the presidential vote, and the presidential candidates themselves, are the same in every Assembly district. The presidential vote is affected by underlying partisanship, national conditions and the characteristics of the presidential candidates, factors that are constant whether that vote is aggregated at the state, district, or ward levels.

To put it another way, a change in the statewide presidential vote is virtually certain to affect state legislative election results. Adding or subtracting hundreds of thousands of Democrats or Republicans will alter voting patterns at the district level. However, nobody would expect that the statewide presidential result will be affected by the configuration of legislative districts. The statewide presidential vote would be the same, no matter how the district lines are drawn. Consequently, we can consider the presidential vote as exogenous to, but a causal factor of, the state legislative vote.

d. Independent Variables: Incumbency

The incumbency advantage is perhaps the most well-known feature of contemporary legislative elections (Jacobson 2009, 30-35). Legislative incumbents rarely lose, and usually win by large margins. All other things being equal, an incumbent will get more votes than a non-

incumbent. The causes of this advantage are less important in this context than its magnitude.[13] The model takes into account the incumbency advantage by noting whether an incumbent is running in an Assembly district.

Incumbency effects are measured with a dummy variable equal to 1 when a candidate is an incumbent, and 0 otherwise,[14] multiplied by the ward voting eligible population to create an interactive variable that accounts for differences in size from one ward to the next. Since the dependent variable is an actual vote count, the value of incumbency – in terms of how many additional votes incumbents receive – will vary with the number of voters who reside in a ward.

e. Independent Variables: County Effects

The last set of variables estimate the effect that county geography has on the Assembly vote. Some counties in Wisconsin are heavily Republican (Ozaukee, Washington, Waukesha) and some heavily Democratic (Dane, Douglas, Milwaukee). It is possible that a voters' county of residence could have an effect on the vote choice, whether because of sorting, socialization or assimilation, or other unobserved effects. Including dummy variables for each county will capture these effects if they exist. There are 71 county variables (excluding Dunn County) set to 1 when a ward is located in that county, 0 otherwise.

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[13] In the political science literature, the incumbency advantage has been attributed to the political skills and campaign experience of officeholders, higher name recognition, fundraising advantages, constituency service, redistricting, and the ability to scare off quality challengers.

[14] Incumbents were identified using 2012 election data in the 2013 *Wisconsin Blue Book*. In the 43rd and 61st Assembly districts two incumbents were paired against each other; these districts were coded as having no incumbent, since the advantage cancels. In the 7th Assembly district, the Democratic incumbent lost in the primary election and ran a write in campaign in the general election. Because the incumbent was not on the ballot, this district is also coded as having no incumbent.

f. Estimation and Results

Using Stata IC 11.2 I performed ordinary least squares regression, using 2012 ward data from contested districts where both Republican and Democratic candidates were on the ballot.[15] Analyzing contested races solves the problem of trying to estimate partisan support in a district where voters have no opportunity to express their support for one side (Gelman and King 1994). The fact that Republicans registered 0 Assembly votes in the 78th district (Madison), and Democrats 0 votes in the 58th district (Washington County), does not mean there are no Republicans in the 78th or Democrats in the 58th districts, or that a Republican or Democratic candidate would receive zero votes if one were on the ballot. Using uncontested races in this initial analysis would produce inaccurate estimates of party strength in those districts.

The results for the Democratic and Republic regression models appear in Table 1.[16] Most variables show the expected effects, particularly the very strong impact of the presidential vote. The r^2 values are extremely high, and the standard errors of the regression models (Root MSE) are low. The model is also extremely accurate: when compared to actual ward vote, the model's predictions of the Republican ward totals are within 16 votes, and the Democratic predictions are within 18 votes.

Figure 4 shows the overall accuracy of the model by plotting the predicted ward level vote totals by the actual vote totals in each ward. Predictions for both Democrats and

[15] This major-party contested definition is standard. It counts as uncontested four districts where one major party candidate was not on the ballot but received votes as a write in (districts 7, 17, 48, and 57), and one district (district 95) where one major party candidate was on the ballot but did not campaign and received only 50 votes (or 0.24%). This is consistent with methods used in the literature, which often uses a 95% threshold for the winning candidate as a standard (Gelman and King 1990, 274).
[16] Standard errors were adjusted to reflect the aggregation (or clustering) of wards into districts. The full set of variables is included in an appendix to this report.

Republicans are grouped tightly around the 45-degree line where predicted and actual values would be equal.

Figure 5 shows the accuracy of the model at the district level, which is the more relevant quantity for real-world applicability. I calculated district level results by aggregating wards into the associated Assembly district, using LTSB assignments. The district-level estimates are very close to the actual vote totals, and the average absolute error is 356 votes for Democratic candidates and 344 votes for Republican candidates.

Table 1
Regression Results: 2012 Assembly Votes, Contested Districts
County fixed effect variables not shown,

	Independent Variable	
Dependent Variable	Assembly Republican Votes	Assembly Democratic Votes
Total Voting Eligible Population	0.009 (.0070)	-0.008 (.0122)
Black Voting Eligible Population	-0.026 (.0215)	-0.021 (.044)
Hispanic Voting eligible Population	-0.0083 (.0321)	-0.149** (.05)
Democratic Presidential Votes	0.0072 (.0173)	0.931*** (.028)
Republican Presidential Votes	0.946*** (.0086)	0.013 (.013)
Democratic Assembly Incumbent	-0.021*** (.006)	0.028*** (.007)
Republican Assembly Incumbent	0.011** (.0042)	-0.014** (.005)
Constant	-0.92 (7.52)	9.8 (5.4)
N	5,282	5,282
r^2	.9903	.9843
Root MS Error	15.8	17.7

Robust standard errors clustered by Assembly District in parentheses.
*p<.05, **p<0.01, ***p<0.001

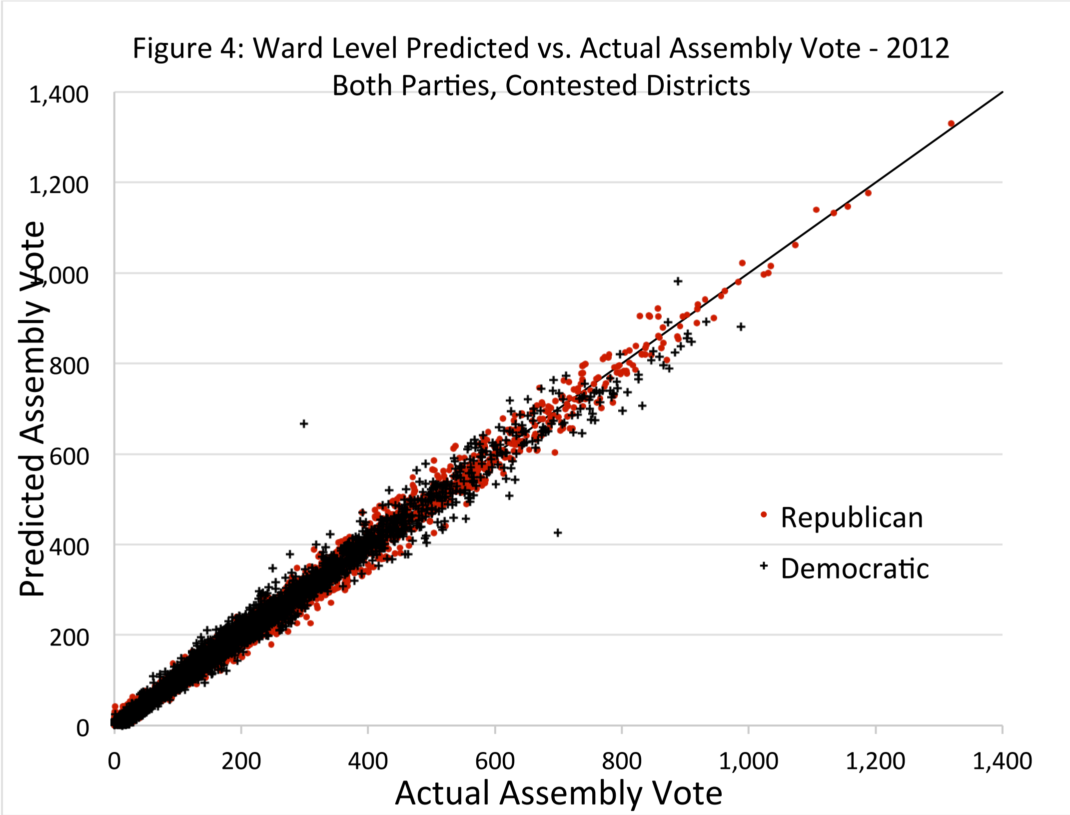
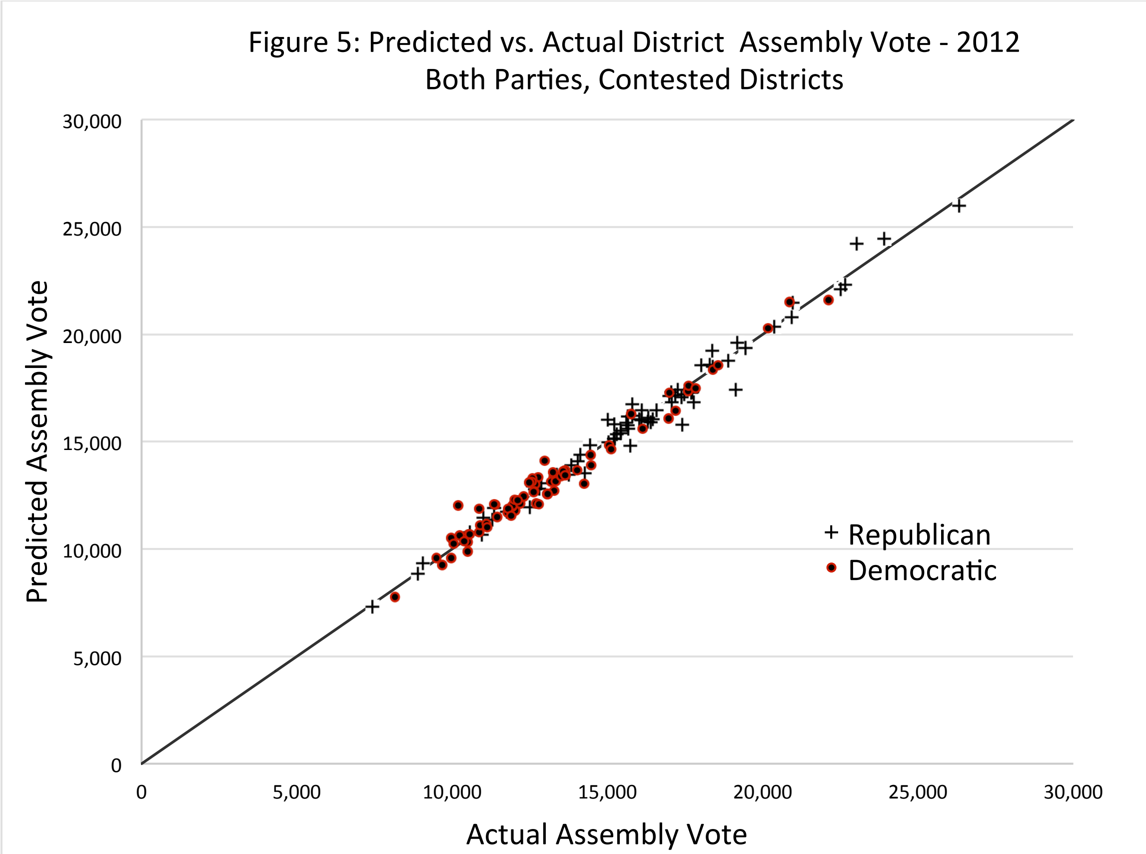


Figure 4: Ward Level Predicted vs. Actual Assembly Vote - 2012
Both Parties, Contested Districts
Predicted Assembly Vote
Actual Assembly Vote
Republican
Democratic
0
200
400
600
800
1,000
1,200
1,400



As important as the prediction of actual district vote totals is the model's ability to accurately identify the winner, as the efficiency gap calculation is sensitive to the party of the winners and losers.[17] The accuracy of the model is shown in Table 2, which gives the actual and predicted vote percentages of the two-party vote for Republican candidates in contested districts.[18]

[17] All of the votes for a losing candidate are defined as wasted, whereas only those votes in excess of the number required to win are wasted for the winner.
[18] The vote percentages were calculated using the actual and predicted vote totals.

Table 2 - Predicted vs. Actual Vote Percentages, Contested Districts

Assembly District	Actual GOP Vote %	Predicted GOP Vote %	Correct Winner?	Error
1	51.3%	52.3%	Y	1.0%
2	58.7%	58.8%	Y	0.1%
3	60.4%	58.6%	Y	-1.8%
4	55.7%	54.6%	Y	-1.0%
5	55.9%	57.6%	Y	1.7%
6	59.5%	59.9%	Y	0.4%
13	60.6%	60.4%	Y	-0.2%
14	59.1%	60.7%	Y	1.6%
15	58.3%	57.1%	Y	-1.2%
20	42.4%	40.9%	Y	-1.5%
21	59.3%	56.9%	Y	-2.5%
23	62.3%	61.8%	Y	-0.5%
24	62.4%	61.0%	Y	-1.4%
25	57.7%	57.0%	Y	-0.7%
26	51.3%	55.1%	Y	3.8%
27	57.8%	54.4%	Y	-3.5%
28	56.2%	56.5%	Y	0.3%
29	55.9%	55.2%	Y	-0.7%
30	55.8%	56.5%	Y	0.7%
31	56.5%	55.9%	Y	-0.7%
32	59.1%	59.7%	Y	0.6%
33	64.9%	63.8%	Y	-1.0%
34	61.3%	60.9%	Y	-0.4%
35	56.0%	55.9%	Y	-0.1%
36	59.0%	60.0%	Y	1.0%
37	54.3%	56.0%	Y	1.7%
38	60.0%	61.9%	Y	1.9%
39	60.4%	60.0%	Y	-0.4%
41	58.0%	57.4%	Y	-0.5%
42	56.6%	54.8%	Y	-1.8%
43	42.3%	42.9%	Y	0.7%
44	38.4%	40.1%	Y	1.7%
45	36.1%	35.2%	Y	-1.0%
46	35.2%	34.5%	Y	-0.7%
47	29.0%	30.2%	Y	1.1%
49	54.4%	54.6%	Y	0.3%
50	51.7%	51.8%	Y	0.1%
51	51.9%	49.9%	N	-2.0%
52	60.7%	60.1%	Y	-0.6%
53	60.1%	62.9%	Y	2.8%
54	39.8%	42.0%	Y	2.3%
55	65.2%	59.2%	Y	-6.1%
56	58.3%	59.7%	Y	1.3%
60	71.2%	72.6%	Y	1.4%
61	55.7%	55.6%	Y	-0.1%
62	53.1%	53.9%	Y	0.8%
63	58.4%	57.7%	Y	-0.6%

67	53.3%	53.5%	Y	0.2%
68	52.4%	50.7%	Y	-1.8%
69	61.2%	58.5%	Y	-2.7%
70	49.7%	50.1%	N	0.4%
71	39.0%	39.3%	Y	0.2%
72	50.2%	51.3%	Y	1.1%
74	41.0%	41.1%	Y	0.1%
75	48.9%	49.2%	Y	0.2%
80	36.1%	35.3%	Y	-0.8%
81	38.1%	39.6%	Y	1.4%
82	60.3%	61.6%	Y	1.4%
83	69.8%	71.6%	Y	1.9%
84	62.8%	61.8%	Y	-1.0%
85	48.2%	48.7%	Y	0.5%
86	55.7%	56.1%	Y	0.4%
87	58.6%	58.3%	Y	-0.3%
88	52.5%	54.1%	Y	1.7%
89	59.1%	59.2%	Y	0.1%
90	39.6%	37.7%	Y	-1.9%
93	50.8%	52.0%	Y	1.2%
94	39.4%	39.4%	Y	0.0%
96	59.6%	59.7%	Y	0.1%
97	64.7%	64.4%	Y	-0.3%
98	70.5%	70.0%	Y	-0.5%
99	76.3%	77.0%	Y	0.7%

The regression model identifies the correct winner in 70 of 72 districts (97.2%); that is, it accurately identifies the candidate who received the most votes. In the two misclassified races, the Republican candidates received 51.9% and 49.7% of the vote. The average absolute error in the vote margin is 1.49%.

g. Out of Sample Forecasting Accuracy

These results, which compare predicted election results to the actual election results, demonstrate that the model is very accurate. A harder test involves the accuracy of predictions using data not in the sample – that is, applying the model to data and election results that are different from the data used to estimate the model. To test the model's out of sample accuracy, I reran the model 72 times (once for every contested district) excluding every ward in one single

contested district each time,[19] and then used the results of that estimation to predict the vote totals in wards in the excluded district using the independent variable values for those wards. For example, in the first run I excluded all wards in Assembly district 2 (see footnote 20), and estimated the model using data from the other seventy one contested districts. I then used the results to predict the vote totals in the 2nd district, and compared the prediction to the actual vote totals. Since we know the actual election results in excluded districts, this exercise is a "hard test" of the model's general predictive ability.

Figure 6 and Table 3 show the results for the 60 contested districts in which the full model could be estimated.[20] The average district forecast error of the Republican vote percentage increased slightly, to 2.1%, but the out of sample forecasts identified the correct winner in 59 out of 60 races (98.3%). In Figure 6, which plots the actual versus predicted vote totals, the points are not grouped as tightly around the 45-degree line as they are in the full model predictions (Figure 5), but still show a very high degree of accuracy.

Table 3 -Out of Sample Predicted vs. Actual Vote Percentages, Contested Districts

Assembly District	Actual GOP Vote %	Predicted GOP Vote %	Correct Winner?	Error
2	58.7%	59.0%	Y	0.3%
3	60.4%	57.5%	Y	-2.9%
4	55.7%	54.3%	Y	-1.3%
5	55.9%	58.9%	Y	2.9%
13	60.6%	60.4%	Y	-0.2%

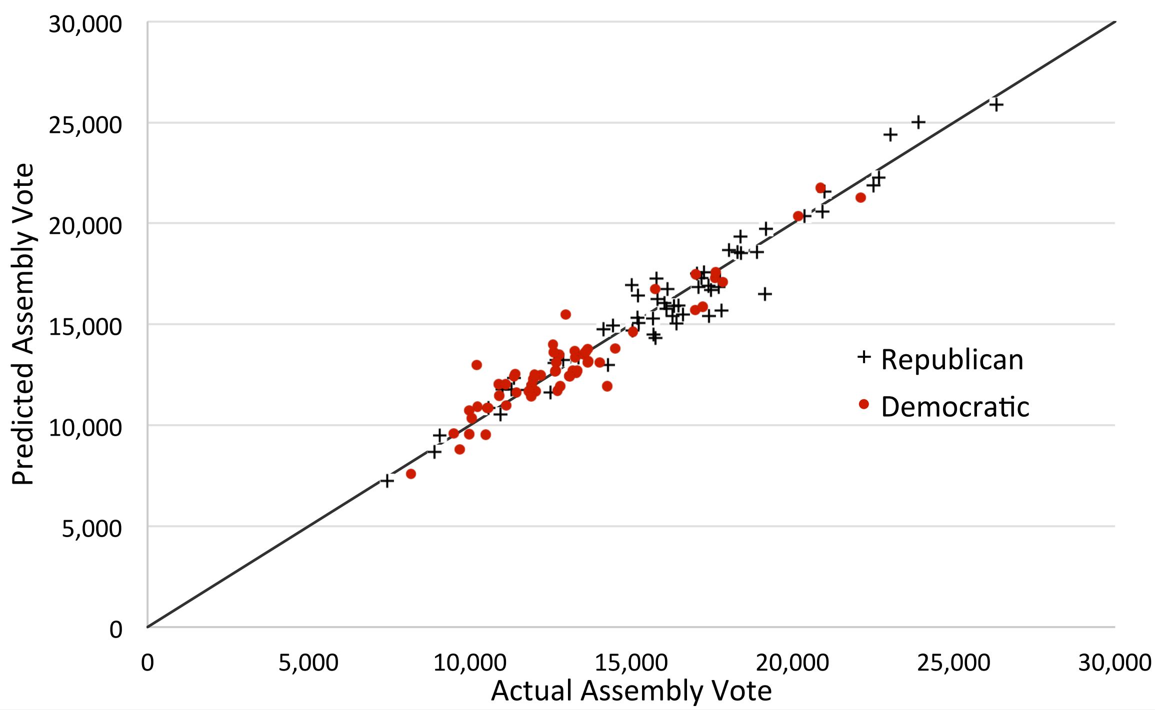
[19] Uncontested districts were not included in the analysis for reasons specified in section B(1)(f) above.

[20] In twelve districts (districts 1, 6, 34, 35, 36, 49, 68, 74, 75, 93, 94 and 96), at least one county was entirely contained in a single district, making it impossible to estimate the fixed effect coefficient value for that county. Consequently, when the out-of-sample predictions were calculated, a variable was missing. An accurate test involves districts for which it was possible to estimate the full model.

14	59.1%	61.0%	Y	1.8%
15	58.3%	56.7%	Y	-1.6%
20	42.4%	39.9%	Y	-2.5%
21	59.3%	56.3%	Y	-3.1%
23	62.3%	61.4%	Y	-0.9%
24	62.4%	60.2%	Y	-2.3%
25	57.7%	55.7%	Y	-2.0%
26	51.3%	58.6%	Y	7.3%
27	57.8%	50.3%	Y	-7.5%
28	56.2%	55.1%	Y	-1.2%
29	55.9%	54.6%	Y	-1.3%
30	55.8%	57.2%	Y	1.4%
31	56.5%	55.7%	Y	-0.9%
32	59.1%	60.2%	Y	1.1%
33	64.9%	63.0%	Y	-1.9%
37	54.3%	56.3%	Y	2.0%
38	60.0%	62.3%	Y	2.3%
39	60.4%	59.0%	Y	-1.5%
41	58.0%	56.2%	Y	-1.7%
42	56.6%	51.8%	Y	-4.8%
43	42.3%	43.3%	Y	1.1%
44	38.4%	40.8%	Y	2.5%
45	36.1%	34.1%	Y	-2.0%
46	35.2%	34.1%	Y	-1.0%
47	29.0%	30.9%	Y	1.8%
50	51.7%	53.1%	Y	1.4%
51	51.9%	48.7%	N	-3.2%
52	60.7%	59.4%	Y	-1.3%
53	60.1%	64.4%	Y	4.4%
54	39.8%	43.8%	Y	4.0%
55	65.2%	56.0%	Y	-9.3%
56	58.3%	59.9%	Y	1.6%
60	71.2%	73.9%	Y	2.8%
61	55.7%	54.9%	Y	-0.8%
62	53.1%	54.5%	Y	1.4%
63	58.4%	57.1%	Y	-1.3%
67	53.3%	54.7%	Y	1.4%
69	61.2%	57.2%	Y	-4.0%
70	49.7%	49.7%	Y	0.0%
71	39.0%	40.1%	Y	1.1%
72	50.2%	53.0%	Y	2.8%
80	36.1%	35.1%	Y	-1.0%
81	38.1%	40.8%	Y	2.6%

82	60.3%	62.0%	Y	1.8%
83	69.8%	71.8%	Y	2.0%
84	62.8%	61.7%	Y	-1.1%
85	48.2%	49.0%	Y	0.8%
86	55.7%	56.9%	Y	1.2%
87	58.6%	54.6%	Y	-3.9%
88	52.5%	54.6%	Y	2.1%
89	59.1%	59.0%	Y	-0.1%
90	39.6%	36.9%	Y	-2.7%
97	64.7%	64.2%	Y	-0.5%
98	70.5%	69.9%	Y	-0.5%
99	76.3%	77.3%	Y	1.0%

Figure 6: Out of Sample Results
Predicted vs. Actual District Assembly Vote Both Parties, Contested Districts



The model does an excellent job accurately forecasting vote totals and election results, and provides a solid foundation for estimating hypothetical vote totals in an alternative district plan.

h. Comparison to 2011 Republican Expert Baseline Partisanship Measure

The method I have outlined here is a standard technique in the analysis of redistricting plans: creating a baseline measure of partisanship that is independent of a particular district configuration, and applying those estimates to alternative hypothetical district plans.

Indeed, in preparing the district plan that would become Act 43, the state legislature went through the same analytical exercise, generating partisanship measures to forecast what the election results would be in the districts enacted in that plan. The expert that the legislative Republicans relied on to conduct that analysis, Dr. Ronald Keith Gaddie, described the process and method as "an effort to create a partisan normal vote measure or a partisan baselining measure to use to apply to different districts to ascertain their political tendency."[21] The results of his regression analysis of the districts in Act 43 are in a spreadsheet used to evaluate the plan entitled "Final Map" which contains open seat baseline partisan estimates for existing and new Assembly districts.

Figure 7 compares Dr. Gaddie's open-seat baseline partisanship measure for the Act 43 districts with the equivalent results of my model, excluding the 8th and 9th Assembly districts which were redrawn by the Federal Court and are therefore not comparable. Gaddie's partisan baseline measure is plotted on the x-axis, and my measure on the y-axis. My measure is the expected partisan performance in actual Act 43 districts, with incumbency effects removed.[22] The two measures are strongly related, indicating that both are capturing stable features of partisanship in Wisconsin. The line is a bivariate regression line produced by using Dr. Gaddie's partisanship estimate as the independent variable and my measure as the dependent variable.

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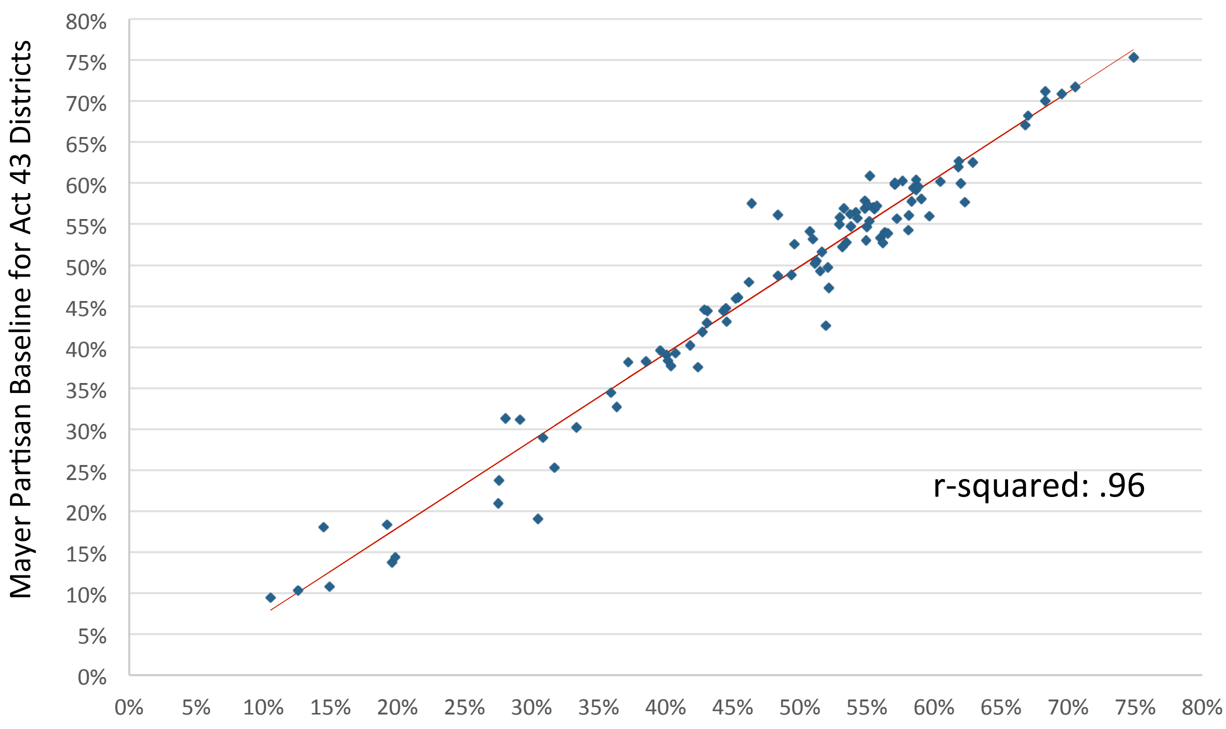
[21] Deposition, January 20, 2012, p. 196.
[22] I generated this data by calculating predicted values for my model in Act 43 districts, setting all incumbency variables to zero.

The r-squared for this regression is 0.96, indicating that the two measures are almost perfectly related, and are both capturing the same underlying partisanship.

The most important characteristics of Gaddie's measure is that it constitutes a true forecast of what was expected to occur in the 2012 elections, since the measure itself was generated in 2011 using data from the 2004-2010 elections. As I show below, this metric can be used to generate an efficiency gap measure of what was likely to happen (indeed, what *did* happen) in the 2012 election.

Figure 7
Gaddie and Mayer Partisan Baselne Metrics Compared for Act 43 Districts



Gaddie Partisan Baseline for Act 43 Districts - Republican Assembly %

2. Step Two – Predicting Votes in a Demonstration District Plan

a. Creating a Demonstration District Plan

With the model parameters in hand, I can estimate baseline partisanship and vote totals in every ward, including those uncontested by both parties (because I have independent variables in all wards, even when only one party is on the Assembly ballot). For uncontested districts, the predicted ward vote totals are what would be expected if both parties ran a candidate, based on the values of the independent variables in the wards. I then use these predicted ward level vote totals to generate vote estimates at the Census block level, and build a demonstration district using Census blocks as my basic unit. Because the variables used in the model are exogenous to district configuration and the out of sample predictions are accurate, the results of the analysis in Step one represent a valid measure of what the Assembly vote would have been in a different district configuration.

I calculated estimated "open seat" vote totals, by subtracting the incumbency advantage in every district in which an incumbent ran. This is a more accurate method of determining the baseline partisanship of a district, as it removes the effect of incumbents, who may or may not be running in an alternative plan. This baseline process is standard in the discipline, and was used by the expert retained by the state legislature, Dr. Ronald Keith Gaddie, to analyze the partisan effects of Act 43 during the redistricting process.

To obtain block level vote estimates, I disaggregated the ward level predicted values for the Democratic and Republican vote totals to individual blocks in that ward, based on each block's share of the ward vote eligible population. This technique is widely used and accepted in the discipline (McDonald 2014; Pavia. and López-Quílez 2013). Census blocks have a voting eligible population range between 0 and 2,988, with an average of approximately 17 people. Wards contain an average of 40 blocks, although the range is substantial, with a minimum of 1

and a maximum of 740. At the end of this disaggregation process, I have a predicted Democratic and Republican Assembly vote total for each Census block in the state.

Table 4 shows an illustrative example, using Ward 23 in the city of Waukesha. This ward, located in the southeastern part of the city, had a 2010 Census population of 1,426, a voting age population of 1,089, and a voting eligible population of 1,071. The voting model generated estimates of 552 Republican and 318 Democratic votes in an open seat Assembly race in that ward. The ward contains twenty five Census blocks ranging in population from 0 to 127, with a voting eligible population range of 0 to 115.

The first column in Table 4 is the block's geographic identifier, a unique code.[23] The next column is the block's voting eligible population (VEP) calculated as described in the previous section by removing noncitizens and institutionalized persons (although there are no prisons in this ward). The third column is the block's share of the ward's total VEP of 1,071; for the first block in the table it is 38 ÷ 1,071= .0352, or 3.52%. The next column is block level Republican vote estimate, calculated as 3.52% the ward Republican vote of 552, or 19.438. While the table rounds these vote totals, I use fractional values in the actual calculations.

[23] The identifier is a combination of state, county, Census tract, and block FIPS codes.

Table 4 - Ward to Block Disaggregation
City of Waukesha Ward 23

Ward Voting Eligible Population				**1,071**
Ward Estimated Republican Assembly Vote				**552**
Ward Estimated Democratic Assembly Vote				**318**
Block Geographic Identifier	**Block VEP**	**Block Share of Ward VEP (Block VEP ÷ 1,071)**	**Block Level Republican Vote Estimate (Block Share * 522)**	**Block Level Democratic Vote Estimate (Block Share * 318)**
551332024001002	38	3.52%	19	11
551332024001003	56	5.24%	29	17
551332024001004	65	6.06%	33	19
551332024001005	30	2.77%	15	9
551332024001007	47	4.37%	24	14
551332024001008	81	7.57%	42	24
551332024001009	12	1.11%	6	4
551332024001010	50	4.70%	26	15
551332024001011	26	2.46%	14	8
551332024001012	25	2.32%	13	7
551332024001013	44	4.14%	23	13
551332024001014	60	5.57%	31	18
551332024001015	30	2.77%	15	9
551332024001016	53	4.99%	28	16
551332024001017	0	0.00%	0	0
551332024002009	10	0.93%	5	3
551332024002010	50	4.68%	26	15
551332024002011	65	6.06%	33	19
551332024002012	37	3.44%	19	11
551332024002013	39	3.61%	20	12
551332024003036	41	3.78%	21	12
551332024003039	15	1.39%	8	4
551332024003040	62	5.76%	32	18
551332024003042	22	2.01%	11	6
551332025005011	115	10.73%	59	34

Next, I input this block level data into a commercial GIS software package used for redistricting (Maptitude for Redistricting 2013, Build 2060) matching each block in the database of estimated votes with the same block in the Maptitude data using the block identification code.

Finally, I drew a redistricting plan with the goal of minimizing the efficiency gap while adhering to the Wisconsin and federal Constitutional requirements of equal population, contiguity, compactness, and respect for political subdivisions. Beyond these criteria. the primary decision rule was creating competitive districts where possible, and balancing the number of districts with large Democratic and Republican majorities.

Figures 8 and 9 show the statewide map and the districts in the Milwaukee area.

Figure 8 – Demonstration Plan Statewide Map

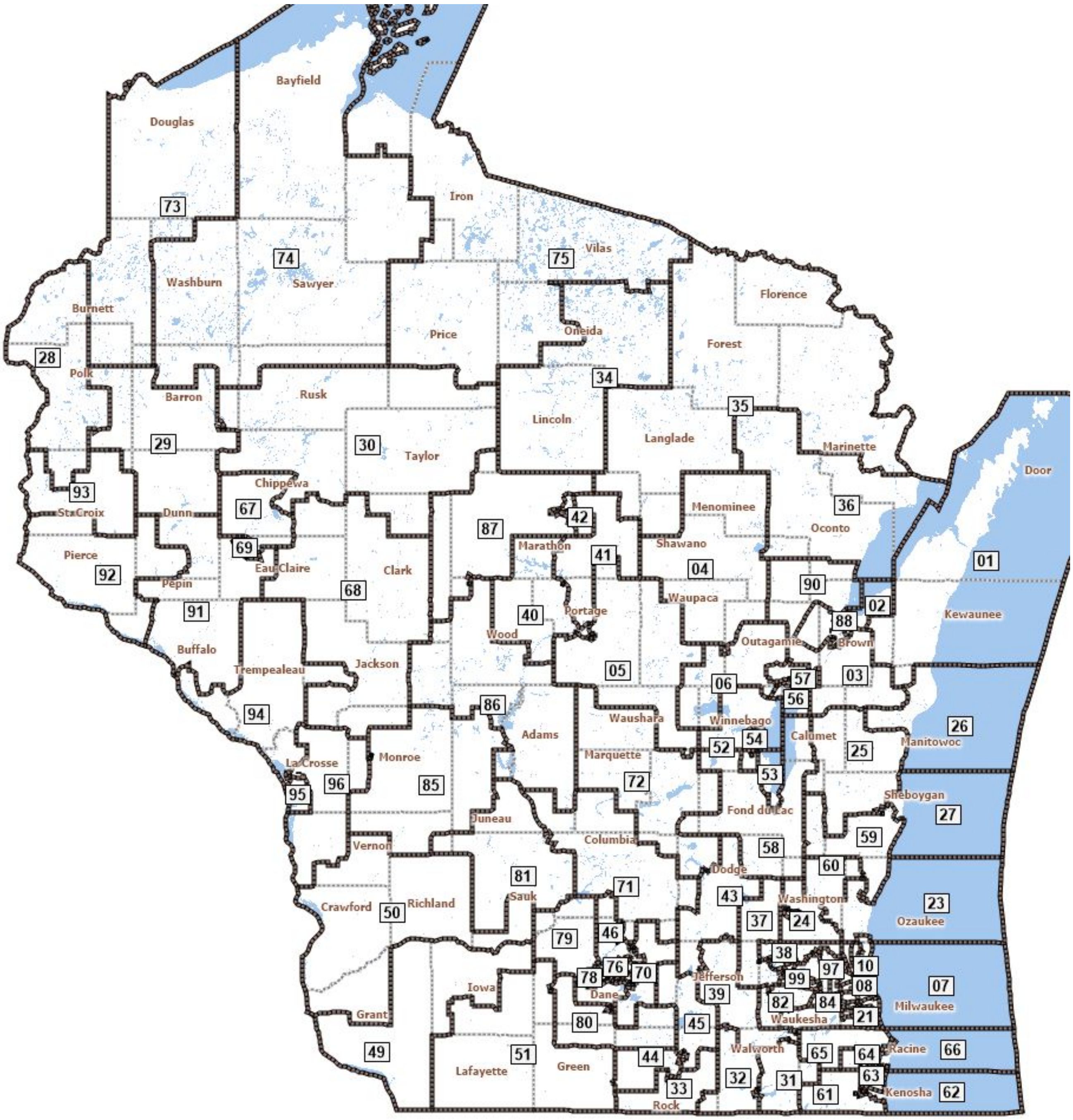
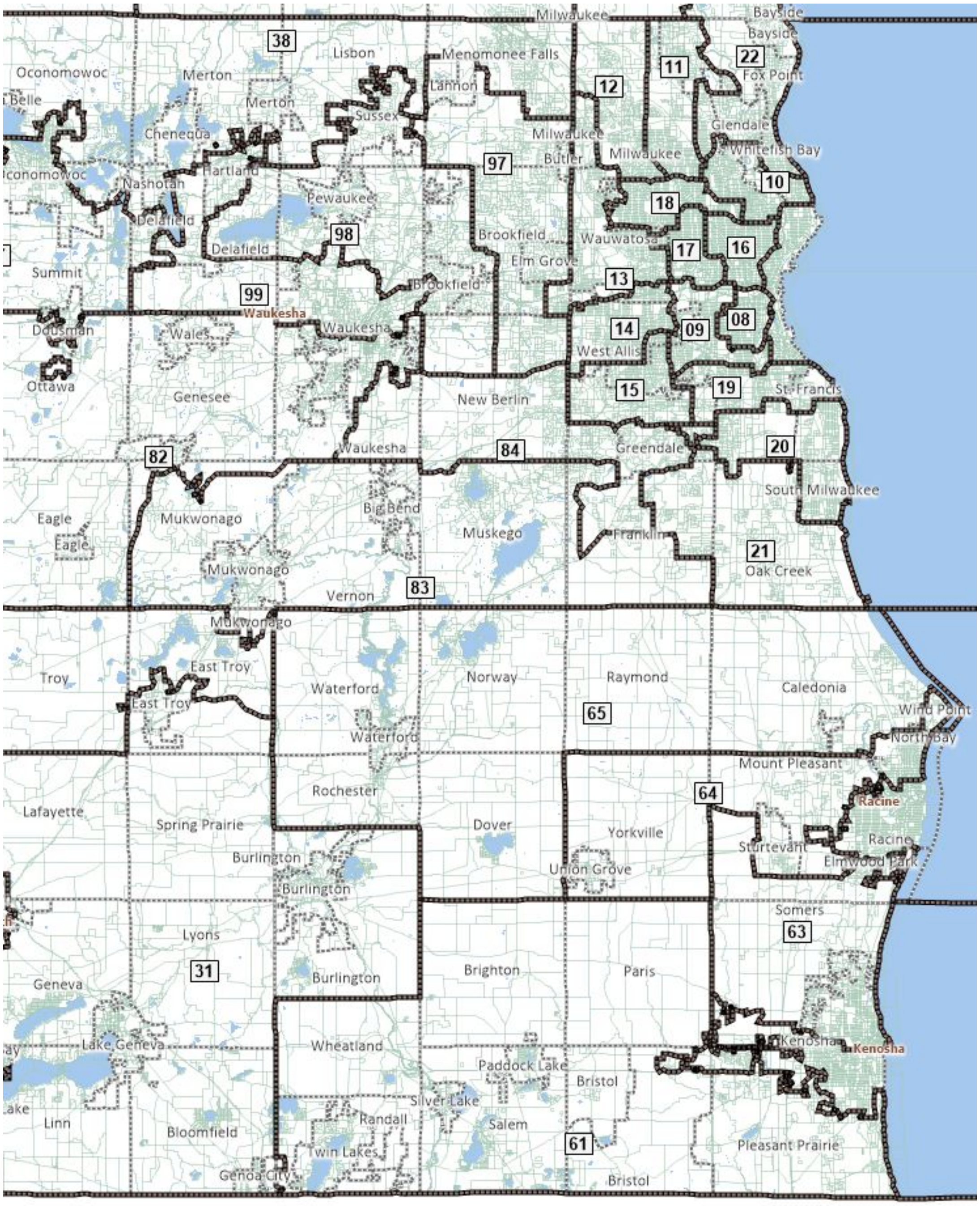


Figure 9 – Demonstration Plan - Milwaukee Area



b. Constitutional and Statutory Requirements

Table 5 shows the summary data for the Demonstration Plan (the full tables are in the annex to this report) and comparison data for the actual 2012 plan implemented in Act 43.[24] The Demonstration Plan has a marginally larger population deviation, but is well below even the strictest standards applied to state legislative districts (a difference of 0.1% translates into 57 people). The population range in the Demonstration Plan is 57,191 to 57,686, a difference of 495 people. Given the ideal Assembly district population of 57,444, this is a deviation of 0.86%. The Demonstration Plan is more compact on average than Act 43, and has fewer municipal splits (119 compared to 120 in Act 43). On all constitutional requirements, the Demonstration Plan is comparable to Act 43.

Table 5 - Plan Comparison to Act 43

		Demonstration Plan	Act 43
Population Deviation		0.86%	0.76%
Average Compactness (Reock)		0.41	0.28
Number of Municipal Splits	County	55	58
	City Town Village	64	62

Act 43 created six majority-minority Black population districts (numbers 10-12 and 16-18), ranging from 56.7% -67.6% Black population, and from 51.1%-61.8% Black voting age population. The Demonstration Plan retains six Majority Black Assembly districts, ranging from 60.0% to 63.4% Black population, and from 56.2% to 60.5% Black voting age population:

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[24] Act 43 figures are taken from the Joint Final Pretrial Report filed in *Baldus et al. vs Brennan et al.*11-CV-562, filed February 24, 2012.

Table 6 - Black Majority Districts in Demonstration Plan

Assembly District	Population	Voting Age Population	Black Population	Black Percentage of Population	Black Voting Age Population	BVAP%
10	57,195	41,528	36,593	64.0%	25,125	60.5%
11	57,455	40,510	34,822	60.6%	22,762	56.2%
12	57,420	38,774	34,923	60.8%	21,829	56.3%
16	57,282	42,469	36,321	63.4%	23,920	56.3%
17	57,437	39,639	34,450	60.0%	22,275	56.2%
18	57,241	40,840	35,316	61.7%	24,054	58.9%

In *Baldus et al. v. Brennan et al.*, a federal Court created a majority Latino district in Milwaukee (the 8th Assembly District). The Demonstration Plan retains the boundaries of this district thereby insuring compliance with Section 2 of the Voting Rights Act.

C. Efficiency Gap Calculations

With the model described in Step one above and the block-level partisanship baseline it generates, I can analyze any existing or hypothetical district configuration and generate predicted vote totals and efficiency gap measures for the Demonstration Plan.

1. Analysis of Act 43

Any discussion of Act 43 must begin with the basic fact that in 2012 Republicans achieved a 60-39 majority in the Assembly in an election in which the Democratic Party achieved 53.5% of the statewide two-party presidential vote. The imbalance between the Republican Party's statewide vote margin at the top of the ticket (46.5%) and its Assembly majority (60.6%) turns the very notion of partisan symmetry on its head. That standard, according to King and Grofman (2007,8) "requires that the number of seats one party would

receive if it garnered a particular percentage of the vote be identical to the number of seats the other party would receive if it had received the same percentage of the vote" (2007,8). Here, it means that Democrats would have had to obtain 60 Assembly seats with 46.5% of the vote, an absurd proposition that requires a party's legislative seat share to go *up* as its share of the vote goes *down*.

This result was achieved via the classic gerrymandering strategies of packing and cracking. Figure 10, a histogram of Republican two party vote percentages in 2012, shows the pattern. Here, the bars to the right of 50% indicate a Republican victory. Twenty three Democratic candidates were uncontested, indicating a significant level of packing (the bar at the far left side of the figure); uncontested races occur largely when one party sees zero probability of winning because the majority party has such overwhelming majorities in the district. By contrast, only four Republicans were uncontested. Act 43 also successfully cracked Democratic majorities in other districts, creating Republican majorities that were either marginal (twelve in the 50-55% range) or relatively safe (thirty nine in the 55-65% range). The 2012 results are consistent with what was forecast in 2011, as shown by Figure 11, a histogram of Dr. Gaddie's baseline partisanship measure for Act 43 districts. This measure forecast fifty one Assembly districts with between 50% and 65% Republican vote share. This is the same number that actually occurred, fifty one.

Figure 12 shows the baseline partisanship district forecasts for Act 43, using the model outline in Step one, above. It is very similar to Dr. Gaddie's forecast and the actual results: it forecast fifty districts with between 50% and 65% Republican vote share.

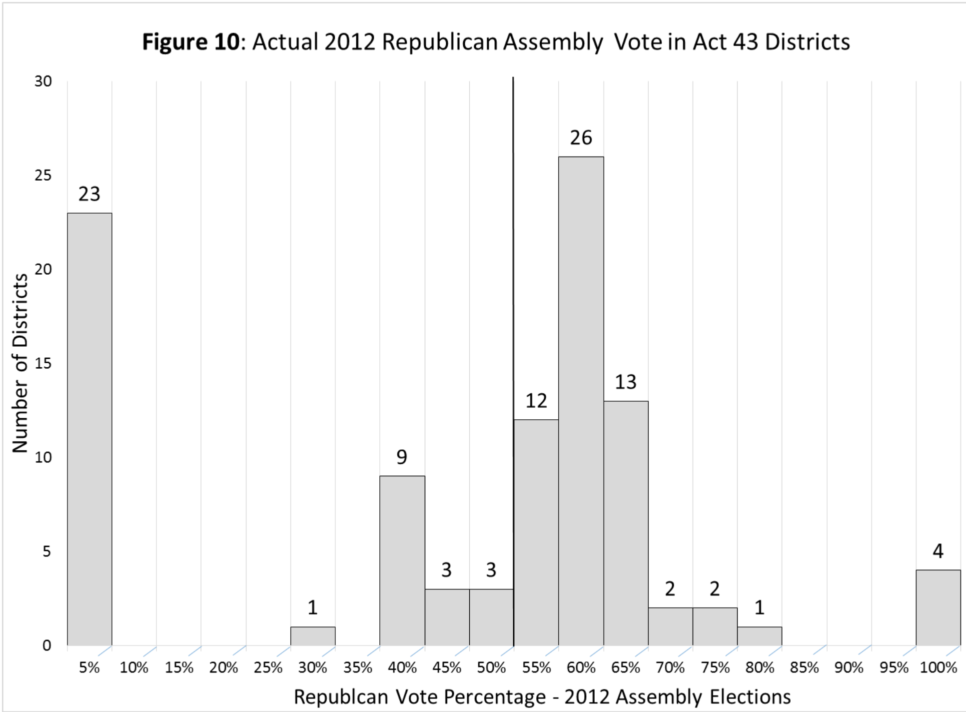


Figure 10: Actual 2012 Republican Assembly Vote in Act 43 Districts
Number of Districts
Republcan Vote Percentage - 2012 Assembly Elections
0
5
10
15
20
25
30
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
23
1
9
3
3
12
26
13
2
2
1
4

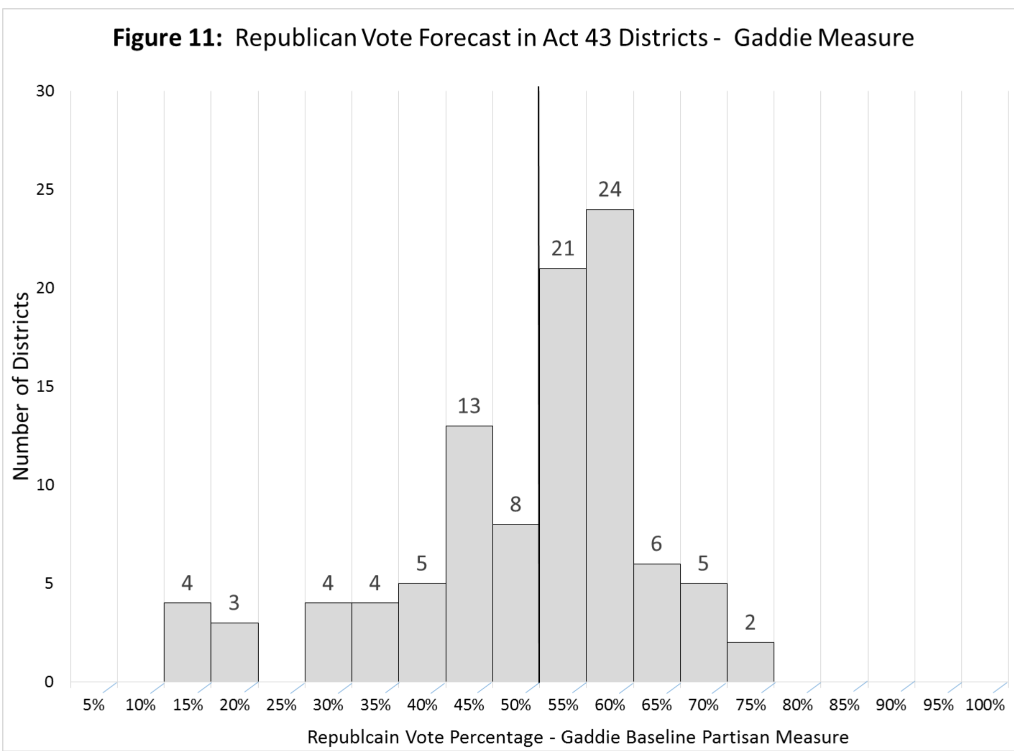
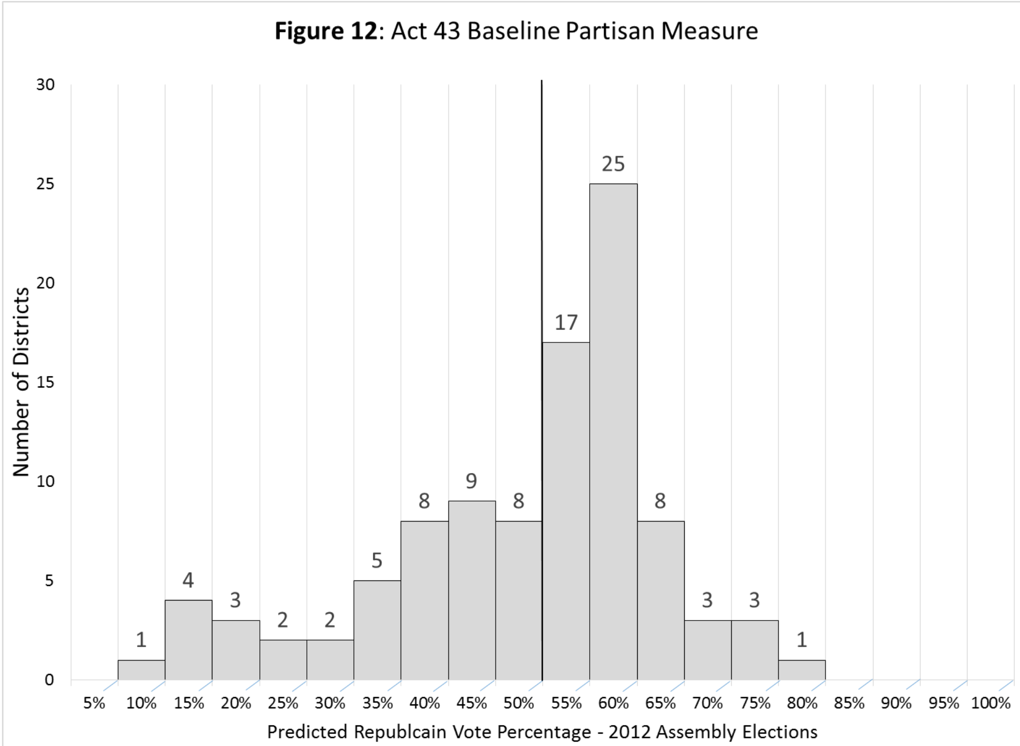


Figure 11: Republican Vote Forecast in Act 43 Districts - Gaddie Measure
Number of Districts
Republcain Vote Percentage - Gaddie Baseline Partisan Measure
0
5
10
15
20
25
30
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
4
3
4
4
5
13
8
21
24
6
5
2



The treatment of the city of Sheboygan shows how this cracking was achieved. Sheboygan is a city on the Lake Michigan shoreline with a population of 49,285. It is a strongly Democratic area, voting 58.7%-41.3% for Obama in 2012; my baseline partisanship estimate for the city is 58.2%. The city is small enough to be contained in a single Assembly district in which it would constitute 86% of the ideal population, and it was entirely within the 26th Assembly district in both the 1992 and 2001 redistricting rounds. The areas surrounding it – the Village of Kohler and the Towns of Sheboygan and Wilson are all strongly Republican (with vote percentages for Romney of 62.8 %, 56.3%, and 59.4%, respectively; together, these municipalities constitute an area that is 58.2% Republican, as measured by the presidential vote).

Keeping the city of Sheboygan together would have created a Democratic district, made up of the city itself (58.7% Democratic) with the remaining 14% of population drawn from one

of the Republican areas around it. The result would have been a District that was roughly 54%-56% Democratic.

Act 43, however, split Sheboygan into separate Assembly districts, placing 32,640 residents of the city into the 26th District, and 16,645 into the 27th. With the city split, these areas were combined into the Republican areas surrounding the city, producing two Republican districts: the 26th (51.3% Republican in the 2012 Assembly race; baseline open seat partisanship measure of 53.3%) and the 27th (57.9% Republican in the 2012 Assembly race, baseline open seat partisanship measure of 52.3%).

Figure 13, below, shows the split into Districts 26 and 27:

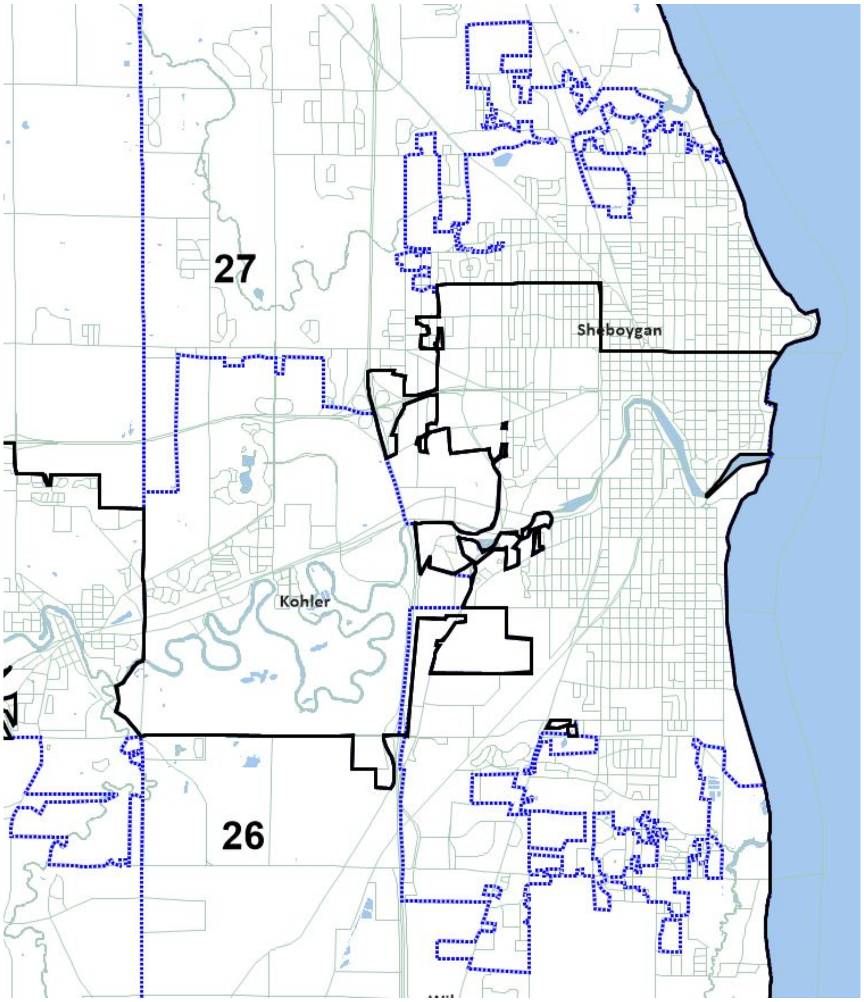


Figure 13– Act 43 Treatment of Sheboygan

2. Efficiency Gap Calculations for Act 43 and The Demonstration Plan

Recall that the efficiency gap is a measure of gerrymandering based on the difference in the number of "wasted votes." Votes cast for losing candidates are wasted, as are surplus votes for winning candidates above what is necessary to win. The gap is defined as the difference between the sum of wasted votes for the two parties, divided by the total number of votes cast in the election.

Comparing a hypothetical district plan (where vote totals are predicted) to an existing district plan (where vote totals are known) requires care, in large part because it can be difficult

to know with certainty what districts will have incumbents (or how incumbents might rearrange themselves after a redistricting cycle), and because not every district will be contested in an actual election (Stephanopoulos and McGhee 2015).

Handling uncontested races is a straightforward problem; the key is applying a consistent rule to all plans being compared. In the efficiency gap calculation for my plan, I measure underlying partisan strength in each district by estimating the number of votes that would be cast for each party in an open seat election each district, *assuming that all races are contested*. In the actual 2012 Assembly elections, only 72 of 99 seats were contested by both major parties, leaving 27 uncontested races. Uncontested races by themselves will not necessarily have a dramatic effect on efficiency gap calculations as long as the number of races is small, or if uncontested districts are evenly split between the parties (as a rule, one uncontested race with only a Democrat will cancel out one uncontested race with only a Republican, conditioned on the number of votes cast in each race). But a significant imbalance in uncontested races will have a material effect on the results. Of the 27 uncontested races in 2012, 23 were in Democratic districts and only 4 in Republican districts.

In the academic redistricting literature, uncontested seats are typically handled by imputing what the vote totals would have been if a race had been contested (Gelman and King 1990), or assigning each uncontested race a 75%-25% vote split in favor of the party whose candidate ran unopposed (Gelman and King 1994; Stephanopoulos and McGhee 2015). Because I have direct measures of partisanship and vote predictions, I am able to generate accurate estimates of what the vote totals would have been in Act 43's uncontested districts had both parties fielded candidates. In applying this method to the uncontested districts in the 2012 State Assembly elections, I create two directly equivalent sets of data: one for the Demonstration Plan,

with predicted values of open seat vote totals for all districts, and one for the districts created in Act 43, using open seat estimates for each district. Efficiency gap results for the two redistricting plans constructed this way can be compared directly.

Table 7 shows the full set of efficiency gap calculations for the Demonstration Plan, with incumbency effects removed. For each district I calculate an estimated Democratic and Republican vote total, and forecast a winner. The resulting columns show the number of "wasted votes," counting all votes cast for a losing candidates, and surplus votes for winning candidates (equal to ½ of the margin of victory). Totals for each party are summed, and the efficiency gap calculated as the Net Wasted Votes (here, Democratic Wasted Votes – Republican Wasted Votes) divided by the total number of votes cast in the election.

The data in Table 7 (on page 48) show that the Demonstration Plan results in 741,984 wasted Democratic votes (column E), obtained by adding the number of lost Democratic votes cast for losing candidates (566,634, column A) and the number of surplus Democratic votes cast for winners above what was necessary to win (175,350, column C). The same calculation for Republicans (using columns B and D) results in 689,570 wasted Republican votes. The difference between these two numbers, 781,984 - 689,570 = 62,414 net wasted Democratic votes. Dividing 62,414 by the predicted total number of votes 2,843,108, produces the baseline efficiency gap for my plan, .0220, or 2.20%.

Table 8 (on page 50) shows the same calculation for Act 43 districts, using estimated partisan vote totals with incumbent advantages removed. Act 43 resulted in a total of 332,552 net wasted Democratic votes. The efficiency gap of Act 43 is 11.69%, more than five times larger than the Demonstration Plan.

Table 9 (on page 52) shows the efficiency gap calculation for the partisan baseline prediction used by Dr. Gaddie during the drawing of the Act 43 districts, applying his partisanship division to the total number of votes predicted from my model in each district. As described above in section III(B)(1)(h) above, this is the predicted baseline partisanship measure of Act 43. It produces a forecast Efficiency Gap for Act 43 of 12.36%.

Table 10 summarizes these results:

	Table 10: Summary Statistics for Redistricting Plans		
	My Plan Baseline	**Act 43 Baseline**	**Act 43 - Gaddie Measure**
party split (R-D)	48-51	57-42	58-41
Wasted Republican Votes	679,570	544,893	535,057
Wasted Democratic Votes	741,984	877,445	886,403
Gap	62,414	332,552	351,346
Total Democratic Votes	1,454,117	1,454,717	1,394,018
Total Republican Votes	1,388,991	1,389,958	1,448,901
Total Votes	2,843,108	2,844,676	2,842,919
Efficiency Gap (gap/total votes)	**2.20%**	**11.69%**	**12.36%**

Three things are worth emphasizing. The first is that the predicted partisan effect of Act 43, represented by the Gaddie metric, produced an efficiency gap calculation (12.36%) that was very close to the actual partisan effect of Act 43, as measured by the efficiency gap calculation for the actual 2012 partisan baseline (11.69%). In brief, the architects of the Act 43 districts expected a partisan result that was almost identical to what actually occurred. The second is the large reduction in the efficiency gap that I am able to produce, which I have achieved without any departure from the core constitutional and statutory requirements of redistricting. The

Demonstration Plan is equivalent to Act 43 on all key criteria: population deviation, compactness, number of political subdivision splits, and compliance with the Voting Rights Act. At the same time, I have generated an efficiency gap score 82% smaller than the Act 43 gap. And third, I have reached this efficiency gap score with virtually identical numbers of Democratic and Republican voters as exist under Act 43. Given that my partisan estimates, once incumbency effects are removed, are *entirely exogenous to any particular district configuration*, these can be considered the same statewide set of voters. By placing the same voters as exist in Act 43 into a new set of districts designed to minimize the effects of gerrymandering while adhering to constitutional standards, I have generated a plan that is fair to both parties.

Figure 14 shows the distribution of baseline Republican vote predictions in the Demonstration Plan Assembly districts. The districts are far more balanced, with similar numbers of districts between 40% - 50% (twenty seven) and between 50% - 60% (twenty nine). There are also roughly equal numbers of districts above 65% (twelve) and below 35% (sixteen).

Figure 14: Predicted Vote - Demonstration Plan

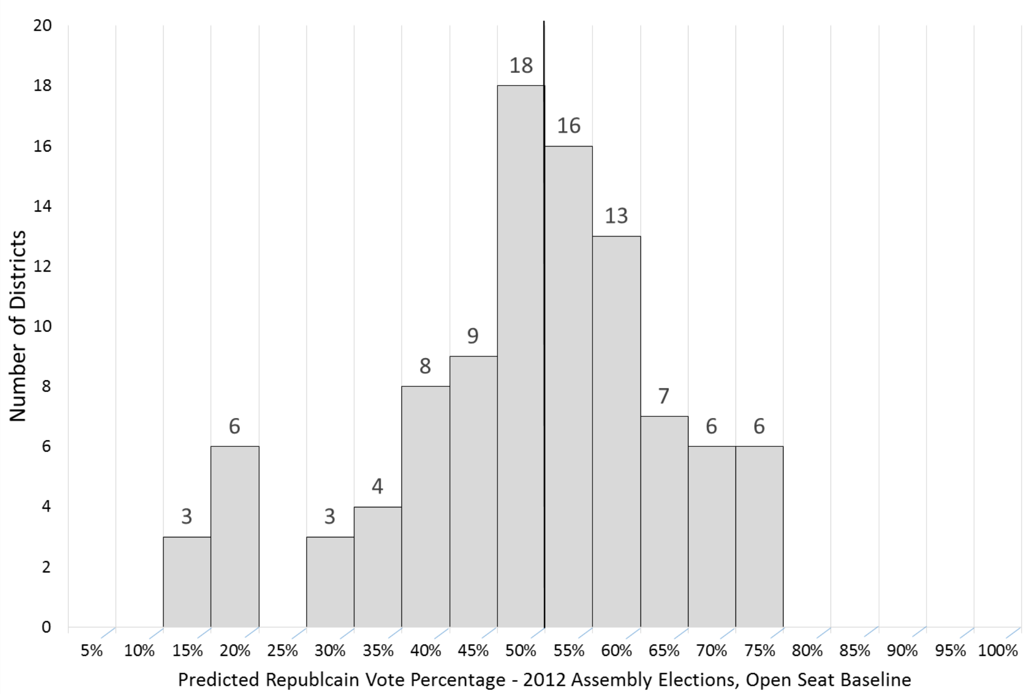


Table 7 - Efficiency Gap Calculation for Demonstration District Plan - No Incumbent Baseline

				A	B	C	D	E	F	
Assembly District	Predicted Democratic Votes	Predicted Republican Votes	Predicted Winning Party	Lost Democratic Votes	Lost Republican Votes	Surplus Democratic Votes	Surplus Republican Votes	Wasted Democratic Votes (A + C)	Wasted Republican Votes (B + D)	Net Wasted Votes (E - F)
1	16,259	16,414	Republican	16259	0	0	78	16259	78	16181
2	11,805	10,025	Democratic	0	10025	890	0	890	10025	-9136
3	11,243	17,807	Republican	11243	0	0	3282	11243	3282	7961
4	10,881	12,790	Republican	10881	0	0	955	10881	955	9926
5	13,497	13,845	Republican	13497	0	0	174	13497	174	13323
6	11,045	17,627	Republican	11045	0	0	3291	11045	3291	7753
7	22,822	10,214	Democratic	0	10214	6304	0	6304	10214	-3910
8	7,192	1,695	Democratic	0	1695	2749	0	2749	1695	1054
9	10,497	5,635	Democratic	0	5635	2431	0	2431	5635	-3205
10	25,348	3,270	Democratic	0	3270	11039	0	11039	3270	7769
11	22,374	4,855	Democratic	0	4855	8759	0	8759	4855	3904
12	20,041	4,039	Democratic	0	4039	8001	0	8001	4039	3962
13	15,950	16,510	Republican	15950	0	0	280	15950	280	15670
14	13,575	13,799	Republican	13575	0	0	112	13575	112	13464
15	13,412	14,901	Republican	13412	0	0	745	13412	745	12667
16	21,234	2,856	Democratic	0	2856	9189	0	9189	2856	6333
17	21,769	3,569	Democratic	0	3569	9100	0	9100	3569	5531
18	23,817	4,954	Democratic	0	4954	9431	0	9431	4954	4477
19	15,160	10,904	Democratic	0	10904	2128	0	2128	10904	-8776
20	14,118	12,901	Democratic	0	12901	609	0	609	12901	-12292
21	12,257	16,911	Republican	12257	0	0	2327	12257	2327	9930
22	18,335	14,831	Democratic	0	14831	1752	0	1752	14831	-13079
23	10,922	25,459	Republican	10922	0	0	7268	10922	7268	3654
24	8,667	25,868	Republican	8667	0	0	8601	8667	8601	66
25	12,179	18,248	Republican	12179	0	0	3034	12179	3034	9145
26	13,251	14,527	Republican	13251	0	0	638	13251	638	12613
27	14,935	11,755	Democratic	0	11755	1590	0	1590	11755	-10165
28	12,617	15,591	Republican	12617	0	0	1487	12617	1487	11131
29	14,180	12,954	Democratic	0	12954	613	0	613	12954	-12341
30	11,308	15,165	Republican	11308	0	0	1929	11308	1929	9379
31	11,304	16,117	Republican	11304	0	0	2406	11304	2406	8898
32	12,685	13,787	Republican	12685	0	0	551	12685	551	12135
33	14,609	10,151	Democratic	0	10151	2229	0	2229	10151	-7922
34	13,139	15,690	Republican	13139	0	0	1275	13139	1275	11864
35	11,288	16,503	Republican	11288	0	0	2607	11288	2607	8681
36	11,516	14,997	Republican	11516	0	0	1741	11516	1741	9775
37	9,222	22,240	Republican	9222	0	0	6509	9222	6509	2713
38	9,710	25,021	Republican	9710	0	0	7655	9710	7655	2055
39	10,747	17,526	Republican	10747	0	0	3390	10747	3390	7357
40	15,061	13,947	Democratic	0	13947	557	0	557	13947	-13391
41	16,784	13,120	Democratic	0	13120	1832	0	1832	13120	-11288
42	13,254	12,282	Democratic	0	12282	486	0	486	12282	-11796
43	12,658	13,606	Republican	12658	0	0	474	12658	474	12184
44	16,477	10,886	Democratic	0	10886	2795	0	2795	10886	-8091
45	16,352	13,589	Democratic	0	13589	1382	0	1382	13589	-12207
46	20,583	11,418	Democratic	0	11418	4582	0	4582	11418	-6835
47	20,208	9,888	Democratic	0	9888	5160	0	5160	9888	-4728

48	24,457	8,840	Democratic	0	8840	7808	0	7808	8840	-1032
49	13,625	13,477	Democratic	0	13477	74	0	74	13477	-13403
50	12,289	13,709	Republican	12289	0	0	710	12289	710	11579
51	14,760	13,323	Democratic	0	13323	718	0	718	13323	-12605
52	12,376	19,416	Republican	12376	0	0	3520	12376	3520	8857
53	12,388	13,362	Republican	12388	0	0	487	12388	487	11902
54	14,032	12,240	Democratic	0	12240	896	0	896	12240	-11344
55	13,565	15,300	Republican	13565	0	0	868	13565	868	12697
56	12,553	14,518	Republican	12553	0	0	983	12553	983	11570
57	14,897	13,016	Democratic	0	13016	941	0	941	13016	-12075
58	9,325	21,180	Republican	9325	0	0	5927	9325	5927	3398
59	11,565	21,984	Republican	11565	0	0	5209	11565	5209	6356
60	8,756	22,415	Republican	8756	0	0	6830	8756	6830	1926
61	12,933	16,576	Republican	12933	0	0	1822	12933	1822	11112
62	15,181	9,999	Democratic	0	9999	2591	0	2591	9999	-7408
63	15,640	9,902	Democratic	0	9902	2869	0	2869	9902	-7033
64	15,089	13,470	Democratic	0	13470	810	0	810	13470	-12660
65	12,721	19,816	Republican	12721	0	0	3547	12721	3547	9173
66	16,286	6,362	Democratic	0	6362	4962	0	4962	6362	-1401
67	15,321	14,226	Democratic	0	14226	547	0	547	14226	-13678
68	11,958	12,124	Republican	11958	0	0	83	11958	83	11875
69	17,902	12,022	Democratic	0	12022	2940	0	2940	12022	-9083
70	18,661	12,266	Democratic	0	12266	3197	0	3197	12266	-9069
71	15,081	13,884	Democratic	0	13884	599	0	599	13884	-13285
72	11,180	16,542	Republican	11180	0	0	2681	11180	2681	8500
73	17,137	10,785	Democratic	0	10785	3176	0	3176	10785	-7609
74	17,712	14,219	Democratic	0	14219	1747	0	1747	14219	-12472
75	13,902	17,700	Republican	13902	0	0	1899	13902	1899	12002
76	30,929	6,811	Democratic	0	6811	12059	0	12059	6811	5248
77	26,708	6,059	Democratic	0	6059	10325	0	10325	6059	4266
78	24,413	9,847	Democratic	0	9847	7283	0	7283	9847	-2564
79	20,439	13,294	Democratic	0	13294	3572	0	3572	13294	-9722
80	20,179	11,644	Democratic	0	11644	4267	0	4267	11644	-7377
81	13,703	12,741	Democratic	0	12741	481	0	481	12741	-12260
82	9,871	21,201	Republican	9871	0	0	5665	9871	5665	4206
83	9,241	23,075	Republican	9241	0	0	6917	9241	6917	2324
84	11,990	22,700	Republican	11990	0	0	5355	11990	5355	6634
85	10,028	13,190	Republican	10028	0	0	1581	10028	1581	8448
86	13,853	13,494	Democratic	0	13494	180	0	180	13494	-13314
87	11,358	17,003	Republican	11358	0	0	2823	11358	2823	8535
88	14,209	11,142	Democratic	0	11142	1533	0	1533	11142	-9609
89	13,374	15,771	Republican	13374	0	0	1199	13374	1199	12175
90	11,349	17,468	Republican	11349	0	0	3059	11349	3059	8290
91	14,807	13,845	Democratic	0	13845	481	0	481	13845	-13364
92	14,907	14,594	Democratic	0	14594	157	0	157	14594	-14437
93	12,441	18,057	Republican	12441	0	0	2808	12441	2808	9633
94	16,171	11,759	Democratic	0	11759	2206	0	2206	11759	-9553
95	19,769	9,949	Democratic	0	9949	4910	0	4910	9949	-5040
96	14,665	13,836	Democratic	0	13836	415	0	415	13836	-13421
97	11,492	24,222	Republican	11492	0	0	6365	11492	6365	5128
98	9,864	24,773	Republican	9864	0	0	7454	9864	7454	2410
99	10,783	19,160	Republican	10783	0	0	4188	10783	4188	6594
TOTALS	**1,454,117**	**1,388,991**		**566,634**	**536,783**	**175,350**	**142,787**	**741,984**	**679,570**	**62,414**

Table 8 - Efficiency Gap Calculation for Act 43 - No Incumbent Baseline

				A	B	C	D	E	F	
Assembly District	Predicted Democratic Votes	Predicted Republican Votes	Predicted Winning Party	Lost Democratic Votes	Lost Republican Votes	Surplus Democratic Votes	Surplus Republican Votes	Wasted Democratic Votes (A + C)	Wasted Republican Votes (B + D)	Net Wasted Votes (E - F)
1	16,235	16,628	Republican	16235	0	0	197	16235	197	16038
2	12,398	16,357	Republican	12398	0	0	1980	12398	1980	10419
3	12,623	16,636	Republican	12623	0	0	2006	12623	2006	10617
4	13,926	15,576	Republican	13926	0	0	825	13926	825	13101
5	12,710	16,017	Republican	12710	0	0	1654	12710	1654	11056
6	10,929	14,938	Republican	10929	0	0	2005	10929	2005	8924
7	13,793	11,778	Democratic	0	11778	1007	0	1007	11778	-10771
8	7,342	1,738	Democratic	0	1738	2802	0	2802	1738	1064
9	10,023	4,533	Democratic	0	4533	2745	0	2745	4533	-1787
10	25,306	2,897	Democratic	0	2897	11205	0	11205	2897	8308
11	21,698	3,368	Democratic	0	3368	9165	0	9165	3368	5797
12	19,700	5,222	Democratic	0	5222	7239	0	7239	5222	2018
13	13,345	20,358	Republican	13345	0	0	3506	13345	3506	9839
14	14,499	21,025	Republican	14499	0	0	3263	14499	3263	11235
15	13,006	17,310	Republican	13006	0	0	2152	13006	2152	10853
16	22,293	2,342	Democratic	0	2342	9975	0	9975	2342	7633
17	24,088	4,047	Democratic	0	4047	10020	0	10020	4047	5973
18	22,204	2,692	Democratic	0	2692	9756	0	9756	2692	7064
19	22,759	10,364	Democratic	0	10364	6198	0	6198	10364	-4166
20	16,066	12,856	Democratic	0	12856	1605	0	1605	12856	-11252
21	12,566	15,324	Republican	12566	0	0	1379	12566	1379	11187
22	11,290	22,958	Republican	11290	0	0	5834	11290	5834	5456
23	14,260	21,633	Republican	14260	0	0	3687	14260	3687	10573
24	13,885	20,335	Republican	13885	0	0	3225	13885	3225	10659
25	12,032	15,933	Republican	12032	0	0	1950	12032	1950	10082
26	13,639	15,559	Republican	13639	0	0	960	13639	960	12679
27	14,709	16,360	Republican	14709	0	0	826	14709	826	13883
28	12,719	15,302	Republican	12719	0	0	1291	12719	1291	11428
29	12,909	14,662	Republican	12909	0	0	876	12909	876	12033
30	14,019	16,951	Republican	14019	0	0	1466	14019	1466	12553
31	13,273	15,615	Republican	13273	0	0	1171	13273	1171	12102
32	11,255	15,359	Republican	11255	0	0	2052	11255	2052	9203
33	11,226	18,298	Republican	11226	0	0	3536	11226	3536	7690
34	12,445	19,355	Republican	12445	0	0	3455	12445	3455	8991
35	12,270	15,525	Republican	12270	0	0	1628	12270	1628	10643
36	11,403	15,672	Republican	11403	0	0	2134	11403	2134	9269
37	12,707	16,202	Republican	12707	0	0	1747	12707	1747	10960
38	12,668	19,129	Republican	12668	0	0	3231	12668	3231	9437
39	11,491	17,211	Republican	11491	0	0	2860	11491	2860	8630
40	11,485	13,597	Republican	11485	0	0	1056	11485	1056	10429
41	11,719	14,492	Republican	11719	0	0	1387	11719	1387	10332
42	13,705	15,462	Republican	13705	0	0	879	13705	879	12826
43	17,380	13,075	Democratic	0	13075	2153	0	2153	13075	-10923
44	16,680	10,304	Democratic	0	10304	3188	0	3188	10304	-7116
45	15,153	9,691	Democratic	0	9691	2731	0	2731	9691	-6959
46	19,173	11,534	Democratic	0	11534	3819	0	3819	11534	-7714
47	21,609	9,340	Democratic	0	9340	6135	0	6135	9340	-3205
48	24,517	7,635	Democratic	0	7635	8441	0	8441	7635	806
49	12,307	13,621	Republican	12307	0	0	657	12307	657	11650

50	12,467	12,326	Democratic	0	12326	71	0	71	12326	-12256
51	14,173	13,048	Democratic	0	13048	563	0	563	13048	-12485
52	11,294	15,656	Republican	11294	0	0	2181	11294	2181	9113
53	9,875	16,753	Republican	9875	0	0	3439	9875	3439	6437
54	15,180	12,882	Democratic	0	12882	1149	0	1149	12882	-11733
55	12,634	16,971	Republican	12634	0	0	2169	12634	2169	10465
56	12,564	18,576	Republican	12564	0	0	3006	12564	3006	9559
57	14,387	11,676	Democratic	0	11676	1355	0	1355	11676	-10321
58	8,843	22,417	Republican	8843	0	0	6787	8843	6787	2055
59	8,784	21,725	Republican	8784	0	0	6471	8784	6471	2313
60	9,848	23,989	Republican	9848	0	0	7071	9848	7071	2778
61	13,145	16,481	Republican	13145	0	0	1668	13145	1668	11477
62	14,828	17,309	Republican	14828	0	0	1240	14828	1240	13588
63	13,233	16,830	Republican	13233	0	0	1799	13233	1799	11434
64	15,702	11,307	Democratic	0	11307	2198	0	2198	11307	-9109
65	15,105	7,929	Democratic	0	7929	3588	0	3588	7929	-4341
66	16,162	5,472	Democratic	0	5472	5345	0	5345	5472	-127
67	13,769	14,674	Republican	13769	0	0	453	13769	453	13316
68	13,663	13,005	Democratic	0	13005	329	0	329	13005	-12676
69	11,083	14,347	Republican	11083	0	0	1632	11083	1632	9451
70	12,211	14,387	Republican	12211	0	0	1088	12211	1088	11123
71	17,614	11,383	Democratic	0	11383	3115	0	3115	11383	-8267
72	14,294	13,895	Democratic	0	13895	199	0	199	13895	-13696
73	17,353	10,784	Democratic	0	10784	3284	0	3284	10784	-7500
74	17,095	13,772	Democratic	0	13772	1662	0	1662	13772	-12110
75	15,000	13,418	Democratic	0	13418	791	0	791	13418	-12627
76	30,939	6,805	Democratic	0	6805	12067	0	12067	6805	5262
77	26,925	6,041	Democratic	0	6041	10442	0	10442	6041	4402
78	24,163	9,857	Democratic	0	9857	7153	0	7153	9857	-2704
79	20,753	13,975	Democratic	0	13975	3389	0	3389	13975	-10586
80	20,369	12,604	Democratic	0	12604	3882	0	3882	12604	-8722
81	16,310	12,356	Democratic	0	12356	1977	0	1977	12356	-10379
82	12,168	18,085	Republican	12168	0	0	2959	12168	2959	9210
83	10,186	23,755	Republican	10186	0	0	6784	10186	6784	3401
84	12,503	18,765	Republican	12503	0	0	3131	12503	3131	9373
85	13,613	12,925	Democratic	0	12925	344	0	344	12925	-12581
86	13,425	17,152	Republican	13425	0	0	1863	13425	1863	11561
87	11,780	15,118	Republican	11780	0	0	1669	11780	1669	10111
88	13,141	14,380	Republican	13141	0	0	620	13141	620	12521
89	11,610	15,516	Republican	11610	0	0	1953	11610	1953	9658
90	12,080	7,309	Democratic	0	7309	2385	0	2385	7309	-4924
91	17,942	11,769	Democratic	0	11769	3086	0	3086	11769	-8683
92	14,285	11,441	Democratic	0	11441	1422	0	1422	11441	-10019
93	15,268	15,393	Republican	15268	0	0	62	15268	62	15206
94	17,408	12,954	Democratic	0	12954	2227	0	2227	12954	-10727
95	19,804	9,627	Democratic	0	9627	5088	0	5088	9627	-4539
96	10,950	14,873	Republican	10950	0	0	1962	10950	1962	8989
97	10,826	18,042	Republican	10826	0	0	3608	10826	3608	7219
98	10,182	21,855	Republican	10182	0	0	5837	10182	5837	4346
99	8,346	25,535	Republican	8346	0	0	8594	8346	8594	-248
TOTALS	**1,454,717**	**1,389,958**		**702,148**	**401,975**	**175,297**	**142,918**	**877,445**	**544,893**	**332,552**

Table 9 - Efficiency Gap Calculation for Act 43 2011 Gaddie Metric - No Incumbent Baseline

				A	B	C	D	E	F	
Assembly District	Predicted Democratic Votes	Predicted Republican Votes	Predicted Winning Party	Lost Democratic Votes	Lost Republican Votes	Surplus Democratic Votes	Surplus Republican Votes	Wasted Democratic Votes (A + C)	Wasted Republican Votes (B + D)	Net Wasted Votes (E - F)
1	15,857	16,651	Republican	15857	0	0	397	15857	397	15461
2	12,983	15,766	Republican	12983	0	0	1391	12983	1391	11591
3	12,976	16,236	Republican	12976	0	0	1630	12976	1630	11346
4	13,742	15,791	Republican	13742	0	0	1025	13742	1025	12717
5	13,134	15,593	Republican	13134	0	0	1230	13134	1230	11904
6	10,779	15,088	Republican	10779	0	0	2155	10779	2155	8624
7	13,967	11,604	Democratic	0	11604	1181	0	1181	11604	-10423
8	6,178	2,709	Democratic	0	2709	1735	0	1735	2709	-974
9	10,173	4,184	Democratic	0	4184	2995	0	2995	4184	-1189
10	24,623	3,547	Democratic	0	3547	10538	0	10538	3547	6992
11	20,235	4,927	Democratic	0	4927	7654	0	7654	4927	2728
12	18,066	6,856	Democratic	0	6856	5605	0	5605	6856	-1251
13	13,929	19,774	Republican	13929	0	0	2922	13929	2922	11007
14	14,693	20,831	Republican	14693	0	0	3069	14693	3069	11624
15	13,497	16,819	Republican	13497	0	0	1661	13497	1661	11835
16	22,223	2,618	Democratic	0	2618	9803	0	9803	2618	7184
17	22,553	5,582	Democratic	0	5582	8486	0	8486	5582	2904
18	21,176	3,719	Democratic	0	3719	8728	0	8728	3719	5009
19	23,838	9,284	Democratic	0	9284	7277	0	7277	9284	-2007
20	16,451	12,471	Democratic	0	12471	1990	0	1990	12471	-10482
21	13,125	14,765	Republican	13125	0	0	820	13125	820	12305
22	11,364	22,885	Republican	11364	0	0	5761	11364	5761	5603
23	15,182	20,658	Republican	15182	0	0	2738	15182	2738	12444
24	14,205	20,015	Republican	14205	0	0	2905	14205	2905	11299
25	13,065	14,887	Republican	13065	0	0	911	13065	911	12154
26	12,853	16,338	Republican	12853	0	0	1743	12853	1743	11110
27	13,611	17,458	Republican	13611	0	0	1923	13611	1923	11688
28	12,609	15,412	Republican	12609	0	0	1401	12609	1401	11208
29	13,519	14,054	Republican	13519	0	0	267	13519	267	13251
30	14,267	16,601	Republican	14267	0	0	1167	14267	1167	13101
31	12,616	16,273	Republican	12616	0	0	1829	12616	1829	10787
32	10,038	16,566	Republican	10038	0	0	3264	10038	3264	6773
33	11,274	18,247	Republican	11274	0	0	3487	11274	3487	7788
34	14,239	17,558	Republican	14239	0	0	1660	14239	1660	12579
35	13,067	14,729	Republican	13067	0	0	831	13067	831	12236
36	12,227	14,848	Republican	12227	0	0	1310	12227	1310	10917
37	12,110	16,799	Republican	12110	0	0	2345	12110	2345	9766
38	12,574	19,218	Republican	12574	0	0	3322	12574	3322	9251
39	10,899	17,782	Republican	10899	0	0	3442	10899	3442	7457
40	10,514	14,561	Republican	10514	0	0	2024	10514	2024	8490
41	11,761	14,467	Republican	11761	0	0	1353	11761	1353	10407
42	13,152	16,036	Republican	13152	0	0	1442	13152	1442	11710
43	17,339	13,113	Democratic	0	13113	2113	0	2113	13113	-10999
44	16,941	10,043	Democratic	0	10043	3449	0	3449	10043	-6595
45	14,886	9,957	Democratic	0	9957	2464	0	2464	9957	-7493
46	17,681	13,010	Democratic	0	13010	2336	0	2336	13010	-10674

47	20,628	10,322	Democratic	0	10322	5153	0	5153	10322	-5169
48	23,290	8,861	Democratic	0	8861	7215	0	7215	8861	-1646
49	13,071	12,859	Democratic	0	12859	106	0	106	12859	-12752
50	11,887	12,908	Republican	11887	0	0	511	11887	511	11376
51	14,637	12,584	Democratic	0	12584	1026	0	1026	12584	-11558
52	11,034	15,918	Republican	11034	0	0	2442	11034	2442	8592
53	9,930	16,099	Republican	9930	0	0	3084	9930	3084	6846
54	15,372	12,690	Democratic	0	12690	1341	0	1341	12690	-11348
55	13,302	16,297	Republican	13302	0	0	1498	13302	1498	11804
56	12,809	18,326	Republican	12809	0	0	2759	12809	2759	10050
57	14,436	11,575	Democratic	0	11575	1431	0	1431	11575	-10145
58	9,211	22,056	Republican	9211	0	0	6422	9211	6422	2789
59	9,669	20,843	Republican	9669	0	0	5587	9669	5587	4083
60	10,307	23,508	Republican	10307	0	0	6601	10307	6601	3706
61	12,661	16,935	Republican	12661	0	0	2137	12661	2137	10524
62	13,959	18,175	Republican	13959	0	0	2108	13959	2108	11851
63	11,973	17,692	Republican	11973	0	0	2860	11973	2860	9113
64	15,452	11,524	Democratic	0	11524	1964	0	1964	11524	-9560
65	14,760	8,274	Democratic	0	8274	3243	0	3243	8274	-5031
66	14,776	6,861	Democratic	0	6861	3957	0	3957	6861	-2904
67	13,748	14,698	Republican	13748	0	0	475	13748	475	13273
68	13,508	13,177	Democratic	0	13177	165	0	165	13177	-13011
69	11,657	13,773	Republican	11657	0	0	1058	11657	1058	10599
70	13,105	13,493	Republican	13105	0	0	194	13105	194	12911
71	17,189	11,807	Democratic	0	11807	2691	0	2691	11807	-9116
72	13,674	14,514	Republican	13674	0	0	420	13674	420	13254
73	16,837	11,300	Democratic	0	11300	2769	0	2769	11300	-8531
74	17,628	13,239	Democratic	0	13239	2195	0	2195	13239	-11044
75	13,590	14,829	Republican	13590	0	0	620	13590	620	12970
76	32,275	5,469	Democratic	0	5469	13403	0	13403	5469	7934
77	26,627	6,339	Democratic	0	6339	10144	0	10144	6339	3804
78	23,528	10,492	Democratic	0	10492	6518	0	6518	10492	-3974
79	20,211	14,516	Democratic	0	14516	2848	0	2848	14516	-11668
80	20,251	12,704	Democratic	0	12704	3773	0	3773	12704	-8931
81	15,887	12,770	Democratic	0	12770	1559	0	1559	12770	-11211
82	12,985	17,269	Republican	12985	0	0	2142	12985	2142	10843
83	10,756	23,185	Republican	10756	0	0	6215	10756	6215	4541
84	13,414	17,854	Republican	13414	0	0	2220	13414	2220	11194
85	13,703	12,843	Democratic	0	12843	430	0	430	12843	-12413
86	15,780	14,789	Democratic	0	14789	495	0	495	14789	-14294
87	12,413	14,420	Republican	12413	0	0	1004	12413	1004	11409
88	12,882	14,638	Republican	12882	0	0	878	12882	878	12004
89	12,009	15,118	Republican	12009	0	0	1554	12009	1554	10455
90	11,556	7,833	Democratic	0	7833	1861	0	1861	7833	-5972
91	18,044	11,816	Democratic	0	11816	3114	0	3114	11816	-8701
92	14,313	11,383	Democratic	0	11383	1465	0	1465	11383	-9919
93	15,014	15,690	Republican	15014	0	0	338	15014	338	14676
94	14,601	15,761	Republican	14601	0	0	580	14601	580	14022
95	18,730	10,701	Democratic	0	10701	4014	0	4014	10701	-6687
96	13,841	11,982	Democratic	0	11982	930	0	930	11982	-11052
97	10,706	18,158	Republican	10706	0	0	3726	10706	3726	6979
98	10,566	21,472	Republican	10566	0	0	5453	10566	5453	5113
99	8,517	25,349	Republican	8517	0	0	8416	8517	8416	102
TOTALS	**1,448,901**	**1,394,018**		**726,238**	**402,334**	**160,165**	**132,723**	**886,403**	**535,057**	**351,346**

D. Conclusions

In this report, I have outlined a method that generates accurate estimates of underlying partisanship using the 2012 presidential election vote, demographics, incumbency, and geographic features to explain patterns of voting in Assembly elections. This method is accurate, as demonstrated by its ability to forecast vote totals at both the individual ward and district levels, and I demonstrate that it generates valid out of sample estimates. It produces results that are very similar to those derived by the expert witness retained by the state legislature during its development of the redistricting map implemented in Act 43.

The results demonstrate that Act 43 was an egregious gerrymander, packing Democratic voters into a small number of districts and distributing Republican voters efficiently in a large number of districts in which they constituted safe majorities. As I demonstrated with the treatment of the city of Sheboygan in Act 43, areas of Democratic strength large enough to constitute majorities in single districts were unnecessarily split and then combined with larger Republican populations to create additional Republican districts and eliminate Democratic districts. The city, which had been in a single Democratic Assembly district since 1992, was split into two Republican districts. This packing and cracking was so successful that Republicans won 61% of Assembly seats in 2012, while obtaining only 46.5% of the statewide presidential vote.

The scope of the gerrymander is demonstrated by the efficiency gap calculation for Act 43: 11.69%. Based on the baseline partisanship estimates produced by Dr. Ronald Keith Gaddie during the drawing of the Act 43 plan, this was the intended outcome: using Gaddie's baseline estimates, Act 43 had an expected efficiency gap of 12.36 %.

However, I drew a demonstration districting plan that was equivalent to Act 43 on population deviation, municipal splits, and compliance with the Voting Rights Act, and better on compactness, with a dramatically lower efficiency gap score of 2.20%. This proves that Act 43's extreme partisan effects were not required by these constitutional or statutory mandates.

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I. Data Issues

The largest errors in the Legislative Technology Services Bureau (LTSB) data occurred because the two data sets used to create this data do not precisely overlap. In GIS argot, the two sets of data are not reported in the same geography. The LTSB files contained data at the individual ward level, while the official election data is aggregated by reporting unit. Wisconsin elections are administered at the ward level, but are often tabulated and released in *reporting units* consisting of multiple wards.[1] Of Wisconsin's roughly 6,530 populated wards, only about a third report election results at the individual ward level; the rest report results by combining wards into reporting units. As one example, the city of Manitowoc (2010 population 33,736) has 25 wards, but reports election results in 10 reporting units of between 2 and 6 wards each.[2]

In order to generate data at the ward level, my understanding is that the LTSB disaggregated reporting unit results to individual wards based on the fraction of Voting Age Population in each ward comprising the reporting unit. In the process a number of anomalies crept into the data. The LTSB file for 2012 contains wards where the number of votes cast exceeds the voting age population; wards with large voting age populations and an unusually low number of votes, often zero, recorded; wards, municipalities, and districts with vote totals that differ substantially from what the Government Accountability Board (GAB) reports; votes allocated to the wrong district; incorrectly numbered and duplicated wards; and wards in uncontested Assembly districts with votes recorded for both political parties.

[1] Wisconsin Statutes 5.15(6)(b) allows municipalities with a population under 35,000 to combine wards for purposes of using a common polling place, and allows for the tabulation and reporting of combined ward vote totals.
[2] In 2012 the reporting units were Wards 1-2; 5-6; 7-8; 9-10; 11-12; 13-14; 15-16; 3, 4, and 22; and 17-18, 21, and 23-25.

In most cases, correcting the errors in the LTSB data involved manually changing the incorrect ward totals to reflect GAB results. When the GAB data were combined into reporting units, I allocated votes to each ward in the unit based on the ward's share of the voting eligible population, removing noncitizen and prison populations.[3] This process generated more accurate ward level data, and is a standard technique when allocating votes into different geographic levels (McDonald 2014; Pavia and López-Quílez 2013). At times, however, the LTSB and GAB data could not be reconciled, because of wards that appeared in one file but not in the other, or discrepancies in ward geography. The votes I was not able to allocate constituted only 0.21% of the total votes cast in the 2012 Assembly election, and have no effect on any subsequent analysis or my conclusions.

The following table shows some of the problems with the data recorded by the LTSB. It displays the errors in the LTSB 2012 presidential vote totals for the city of Mequon. The GAB Reports columns show the vote totals for each of the city's reporting units taken from the 2014 Wisconsin Blue Book, which I take to be authoritative.[4] The LTSB Data columns show the results of combining the individual ward data in the LTSB ward file into the GAB reporting units. The Difference columns show the errors in the LTSB data. While the vote totals for the municipality are the same in both data sets, every ward total is different.

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[3] The voting eligible population (VEP) adjusts the voting age population by removing adults who are not eligible to vote. In Wisconsin, the two largest categories of ineligible adults are noncitizens and adults in prison for felonies. Noncitizens were removed using the 2008-2012 5 year American Community Survey county level noncitizen estimates (available at http://www.census.gov/acs/www/data_documentation/2012_release/. Institutionalized prison populations were identified and removed using Census Bureau "Advanced Group Quarters" files for Wisconsin, available at http://www2.census.gov/census_2010/02-Advance_Group_Quarters/, and described in http://www.census.gov/newsroom/releases/archives/2010_census/cb11-tps13.html.

[4] Table: Vote for President and Vice President by Ward, November 6, 2012 General Election, 938.

Differences Between GAB Reports and LTSB Data
2012 Presidential Election Results for Mequon, WI (Ozaukee County)

	GAB Reports			LTSB Data			Difference		
Reporting Unit (wards)	Obama Votes	Romney Votes	Total Votes	Obama Votes	Romney Votes	Total Votes	Obama Votes	Romney Votes	Total Votes
1	534	890	1424	849	1,522	2,371	315	632	947
2	120	391	511	240	633	873	120	242	362
3,4	637	1,249	1886	415	833	1,248	(222)	(416)	(638)
5, 7B	205	603	808	155	311	466	(50)	(292)	(342)
6, 7A	392	909	1301	292	589	881	(100)	(320)	(420)
8 ,9,10	737	1,245	1982	477	956	1,433	(260)	(289)	(549)
11, 12	635	1,126	1761	527	1,057	1,584	(108)	(69)	(177)
13, 14	353	770	1123	253	506	759	(100)	(264)	(364)
15	380	494	874	579	896	1,475	199	402	601
16	221	491	712	357	766	1,123	136	275	411
17	336	459	795	517	824	1,341	181	365	546
18	204	368	572	322	607	929	118	239	357
19,20,21	639	1,331	1970	410	826	1,236	(229)	(505)	(734)
Totals	5,393	10,326	15,719	5,393	10,326	15,719	0	0	0

Correcting these totals required manually changing the single-ward vote counts to match the GAB data, and allocating votes in reporting units to the individual wards based on the voting-eligible population in each ward in the unit (in the following table, wards in a reporting unit are framed together):

Allocation of Reporting Unit Data to Ward Data

City of Mequon, 2012 Presidential Vote

	GAB Data				Data Used in Voting Model		
Ward	**Obama Votes**	**Romney Votes**	**Ward Voting Eligible Population**	**Ward Share of Reporting Unit VEP**	**Obama Votes**	**Romney Votes**	**Total Votes**
1	534	890	-	-	534	890	1,424
2	120	391	-	-	120	391	511
3	637	1249	1063	53%	336	658	994
4			954	47%	301	591	892
5	205	603	501	67%	137	402	539
7B			250	33%	68	201	269
6	392	909	1240	87%	343	794	1,137
7A			179	13%	49	115	164
8	737	1245	599	26%	192	324	516
9			457	20%	146	247	393
10			1247	54%	399	674	1,073
11	635	1126	1530	60%	380	673	1,053
12			1029	40%	255	453	708
13	353	770	761	63%	221	482	703
14			455	37%	132	288	420
15	380	494	-	-	380	494	874
16	221	491	-	-	221	491	712
17	336	459	-	-	336	459	795
18	204	368	-	-	204	368	572
19	639	1331	908	46%	291	606	897
20			776	39%	249	518	767
21			310	16%	99	207	306
Totals	5,393	10,326			5,393	10,326	15,719

I repeated this process for every instance of inaccurate vote totals in the LTSB, using GAB data as the reference.

II. Full Regression Results

Republican vote totals (bold variables have p<.05)

Independent Variable: Assembly Republican Votes

Dependent Variable	Coefficient	Robust Std. Error	t-statistic	P-value
Total Voting Eligible Population	0.01	0.01	1.32	0.19
Black Voting Eligible Population	-0.03	0.02	-1.21	0.229
Hispanic Voting eligible Population	-0.01	0.03	-0.26	0.796
Democratic Presidential Votes	0.01	0.02	0.42	0.677
Republican Presidential Votes	**0.95**	**0.01**	**110.00**	**0**
Democratic Assembly Incumbent	**-0.02**	**0.01**	**-3.63**	**0.001**
Republican Assembly Incumbent	**0.01**	**0.00**	**2.62**	**0.011**
Adams	-7.27	7.24	-1.00	0.319
Ashland	3.07	7.81	0.39	0.695
Barron	-11.03	7.13	-1.55	0.126
Bayfield	-0.59	7.77	-0.08	0.94
Brown	**-17.12**	**8.29**	**-2.07**	**0.042**
Buffalo	-7.93	7.35	-1.08	0.284
Burnett	-1.97	7.31	-0.27	0.789
Calumet	**17.29**	**7.31**	**2.36**	**0.021**
Chippewa	4.20	10.58	0.40	0.693
Clark	6.23	7.74	0.81	0.423

Columbia	15.01	10.08	1.49	0.141
Crawford	**28.20**	**7.24**	**3.90**	**0**
Dane	1.55	8.53	0.18	0.857
Dodge	8.54	7.88	1.08	0.282
Door	**16.98**	**7.23**	**2.35**	**0.022**
Douglas	-3.14	7.65	-0.41	0.682
EauClaire	0.47	7.83	0.06	0.953
Florence	-7.34	7.52	-0.98	0.332
FondduLac	4.74	8.07	0.59	0.559
Forest	-1.91	7.39	-0.26	0.796
Grant	**24.64**	**7.23**	**3.41**	**0.001**
Green	14.41	9.95	1.45	0.152
GreenLake	11.96	7.36	1.62	0.109
Iowa	15.04	8.08	1.86	0.067
Iron	**20.54**	**7.68**	**2.67**	**0.009**
Jackson	5.74	7.53	0.76	0.449
Jefferson	2.37	8.41	0.28	0.779
Juneau	-4.31	7.29	-0.59	0.556
Kenosha	3.73	7.99	0.47	0.642
Kewaunee	-14.13	7.24	-1.95	0.055
LaCrosse	**-26.58**	**8.43**	**-3.15**	**0.002**
Lafayette	**18.18**	**7.29**	**2.49**	**0.015**
Langlade	4.35	8.30	0.52	0.602
Lincoln	-0.38	7.53	-0.05	0.96
Manitowoc	**19.35**	**9.36**	**2.07**	**0.042**
Marathon	2.01	8.56	0.24	0.815
Marinette	**19.89**	**8.04**	**2.48**	**0.016**
Marquette	6.91	7.26	0.95	0.344
Menominee	-3.08	7.32	-0.42	0.675
Milwaukee	1.96	11.98	0.16	0.871
Monroe	**19.47**	**7.72**	**2.52**	**0.014**
Oconto	3.21	7.95	0.40	0.687
Oneida	12.01	7.95	1.51	0.136
Outagamie	1.90	8.02	0.24	0.814
Ozaukee	13.71	8.82	1.55	0.125
Pepin	-9.83	7.27	-1.35	0.181
Pierce	-9.31	7.18	-1.30	0.199
Polk	-3.47	7.24	-0.48	0.633
Portage	**-20.74**	**7.71**	**-2.69**	**0.009**
Price	5.25	7.75	0.68	0.501
Racine	-6.90	8.23	-0.84	0.404
Richland	16.24	8.55	1.90	0.062
Rock	9.24	8.32	1.11	0.27

Rusk	3.71	7.37	0.50	0.616
SaintCroix	13.80	9.31	1.48	0.143
Sauk	**16.68**	**8.27**	**2.02**	**0.048**
Sawyer	-0.90	7.40	-0.12	0.903
Shawano	2.70	7.86	0.34	0.733
Sheboygan	-6.50	15.54	-0.42	0.677
Taylor	9.96	7.30	1.37	0.176
Trempealeau	1.29	7.21	0.18	0.859
Vernon	**31.54**	**7.29**	**4.33**	**0**
Vilas	3.61	7.64	0.47	0.638
Walworth	-2.00	8.17	-0.24	0.807
Washburn	-10.80	7.31	-1.48	0.144
Washington	14.16	12.70	1.12	0.269
Waukesha	1.18	7.93	0.15	0.882
Waupaca	-8.08	7.26	-1.11	0.27
Waushara	-3.47	7.30	-0.48	0.636
Winnebago	30.00	17.09	1.76	0.084
Wood	-7.60	8.96	-0.85	0.399
Constant	-0.92	7.52	-0.12	0.903

N	5282.00
R-squared	0.9903
Root MSE	15.823

Democratic vote totals

Independent Variable: Assembly Democratic Votes

Dependent Variable	Coefficient	Robust Std. Error	t-statistic	P-value
Total Voting Eligible Population	-0.01	0.01	-0.65	0.52
Black Voting Eligible Population	-0.02	0.04	-0.49	0.63
Hispanic Voting Eligible Population	**-0.15**	**0.05**	**-3.01**	**0.00**
Democratic Presidential Votes	**0.93**	**0.03**	**33.33**	**0.00**
Republican Presidential Votes	0.01	0.01	0.98	0.33
Democratic Assembly Incumbent	**0.03**	**0.01**	**3.85**	**0.00**
Republican Assembly Incumbent	**-0.01**	**0.01**	**-2.77**	**0.01**
Adams	**-14.45**	**6.73**	**-2.15**	**0.04**
Ashland	-4.78	5.58	-0.86	0.40
Barron	**14.57**	**4.04**	**3.60**	**0.00**
Bayfield	-2.82	5.58	-0.50	0.62
Brown	**-21.57**	**7.80**	**-2.77**	**0.01**
Buffalo	5.10	4.86	1.05	0.30
Burnett	-3.84	4.69	-0.82	0.42
Calumet	**-26.32**	**5.81**	**-4.53**	**0.00**
Chippewa	0.98	9.53	0.10	0.92
Clark	-6.83	4.80	-1.42	0.16
Columbia	**-19.51**	**8.15**	**-2.39**	**0.02**
Crawford	**-32.57**	**4.33**	**-7.51**	**0.00**
Dane	-9.39	7.20	-1.31	0.20
Dodge	-8.49	5.27	-1.61	0.11
Door	**-11.92**	**4.51**	**-2.64**	**0.01**
Douglas	-7.18	5.40	-1.33	0.19
EauClaire	1.05	7.22	0.14	0.89
Florence	**-13.53**	**5.33**	**-2.54**	**0.01**
FondduLac	**-25.18**	**4.92**	**-5.12**	**0.00**
Forest	-10.83	6.06	-1.79	0.08

Grant	**-23.14**	**4.26**	**-5.43**	**0.00**
Green	**-15.68**	**6.63**	**-2.36**	**0.02**
GreenLake	**-17.01**	**4.65**	**-3.66**	**0.00**
Iowa	**-19.48**	**4.91**	**-3.96**	**0.00**
Iron	**-30.91**	**5.54**	**-5.58**	**0.00**
Jackson	-12.37	6.44	-1.92	0.06
Jefferson	**-17.18**	**7.09**	**-2.42**	**0.02**
Juneau	-5.78	4.55	-1.27	0.21
Kenosha	1.78	5.33	0.33	0.74
Kewaunee	**17.69**	**4.41**	**4.01**	**0.00**
LaCrosse	**25.17**	**6.69**	**3.76**	**0.00**
Lafayette	**-22.66**	**4.58**	**-4.95**	**0.00**
Langlade	**-22.20**	**6.05**	**-3.67**	**0.00**
Lincoln	**-13.42**	**5.15**	**-2.61**	**0.01**
Manitowoc	**-15.90**	**5.49**	**-2.90**	**0.01**
Marathon	-5.64	6.20	-0.91	0.37
Marinette	**-26.28**	**4.22**	**-6.23**	**0.00**
Marquette	**-15.87**	**4.48**	**-3.54**	**0.00**
Menominee	**-61.44**	**4.41**	**-13.95**	**0.00**
Milwaukee	**-29.20**	**6.47**	**-4.51**	**0.00**
Monroe	**-26.83**	**5.44**	**-4.93**	**0.00**
Oconto	**-12.99**	**4.42**	**-2.94**	**0.00**
Oneida	**-35.94**	**5.19**	**-6.92**	**0.00**
Outagamie	**-14.60**	**6.94**	**-2.10**	**0.04**
Ozaukee	**-17.19**	**5.83**	**-2.95**	**0.00**
Pepin	6.62	4.52	1.46	0.15
Pierce	**12.49**	**4.00**	**3.12**	**0.00**
Polk	5.81	4.32	1.35	0.18
Portage	-0.04	5.13	-0.01	0.99
Price	**-14.62**	**5.64**	**-2.59**	**0.01**
Racine	4.42	5.29	0.83	0.41
Richland	**-26.22**	**5.30**	**-4.95**	**0.00**
Rock	-4.48	8.87	-0.50	0.62
Rusk	-8.01	4.90	-1.64	0.11
SaintCroix	-6.89	6.67	-1.03	0.31
Sauk	**-19.42**	**6.51**	**-2.98**	**0.00**
Sawyer	-6.06	4.64	-1.30	0.20
Shawano	**-14.93**	**4.58**	**-3.26**	**0.00**
Sheboygan	15.96	17.17	0.93	0.36
Taylor	-6.81	4.56	-1.49	0.14
Trempealeau	-3.89	4.29	-0.91	0.37
Vernon	**-32.42**	**4.52**	**-7.18**	**0.00**
Vilas	**-27.14**	**5.48**	**-4.95**	**0.00**

Walworth	0.34	5.26	0.07	0.95
Washburn	6.43	4.74	1.36	0.18
Washington	**-19.23**	**9.75**	**-1.97**	**0.05**
Waukesha	**-17.63**	**5.55**	**-3.18**	**0.00**
Waupaca	**-10.48**	**4.37**	**-2.40**	**0.02**
Waushara	0.21	4.64	0.04	0.97
Winnebago	**-32.12**	**15.94**	**-2.02**	**0.05**
Wood	8.14	6.01	1.35	0.18
Constant	9.80	5.39	1.82	0.07

N	5282.00
R-squared	0.9843
Root MSE	17.675

III. Plan characteristics

A. Population deviation

Assembly District	Population	Deviation from Ideal	% Deviation
1	57,487	43	0.07%
2	57,590	146	0.25%
3	57,686	242	0.42%
4	57,406	-38	-0.07%
5	57,633	189	0.33%
6	57,480	36	0.06%
7	57,208	-236	-0.41%
8	57,196	-248	-0.43%
9	57,420	-24	-0.04%
10	57,195	-249	-0.43%
11	57,455	11	0.02%
12	57,420	-24	-0.04%
13	57,248	-196	-0.34%
14	57,333	-111	-0.19%
15	57,514	70	0.12%
16	57,282	-162	-0.28%
17	57,437	-7	-0.01%
18	57,241	-203	-0.35%
19	57,313	-131	-0.23%
20	57,410	-34	-0.06%
21	57,434	-10	-0.02%
22	57,526	82	0.14%
23	57,476	32	0.06%
24	57,369	-75	-0.13%
25	57,480	36	0.06%
26	57,552	108	0.19%
27	57,191	-253	-0.44%
28	57,515	71	0.12%
29	57,300	-144	-0.25%
30	57,407	-37	-0.06%
31	57,429	-15	-0.03%
32	57,349	-95	-0.17%
33	57,391	-53	-0.09%
34	57,651	207	0.36%
35	57,528	84	0.15%
36	57,377	-67	-0.12%

37	57,671	227	0.40%
38	57,572	128	0.22%
39	57,457	13	0.02%
40	57,495	51	0.09%
41	57,671	227	0.40%
42	57,559	115	0.20%
43	57,444	0	0.00%
44	57,434	-10	-0.02%
45	57,242	-202	-0.35%
46	57,463	19	0.03%
47	57,494	50	0.09%
48	57,568	124	0.22%
49	57,389	-55	-0.10%
50	57,465	21	0.04%
51	57,247	-197	-0.34%
52	57,384	-60	-0.10%
53	57,444	0	0.00%
54	57,443	-1	0.00%
55	57,446	2	0.00%
56	57,342	-102	-0.18%
57	57,404	-40	-0.07%
58	57,436	-8	-0.01%
59	57,554	110	0.19%
60	57,547	103	0.18%
61	57,605	161	0.28%
62	57,632	188	0.33%
63	57,299	-145	-0.25%
64	57,266	-178	-0.31%
65	57,601	157	0.27%
66	57,459	15	0.03%
67	57,378	-66	-0.11%
68	57,254	-190	-0.33%
69	57,424	-20	-0.03%
70	57,415	-29	-0.05%
71	57,228	-216	-0.38%
72	57,654	210	0.37%
73	57,491	47	0.08%
74	57,320	-124	-0.22%
75	57,255	-189	-0.33%
76	57,586	142	0.25%
77	57,398	-46	-0.08%
78	57,579	135	0.24%
79	57,341	-103	-0.18%

80	57,385	-59	-0.10%
81	57,266	-178	-0.31%
82	57,641	197	0.34%
83	57,612	168	0.29%
84	57,375	-69	-0.12%
85	57,529	85	0.15%
86	57,477	33	0.06%
87	57,661	217	0.38%
88	57,533	89	0.15%
89	57,490	46	0.08%
90	57,617	173	0.30%
91	57,374	-70	-0.12%
92	57,421	-23	-0.04%
93	57,280	-164	-0.29%
94	57,509	65	0.11%
95	57,496	52	0.09%
96	57,406	-38	-0.07%
97	57,487	43	0.07%
98	57,485	41	0.07%
99	57,657	213	0.37%

B. Compactness (Reock or smallest circle measure)

Assembly District	Smallest Circle Measure
1	0.44
2	0.46
3	0.42
4	0.55
5	0.39
6	0.35
7	0.52
8	0.66
9	0.39
10	0.45
11	0.39
12	0.36
13	0.28
14	0.44
15	0.49
16	0.52
17	0.52

18	0.30
19	0.30
20	0.44
21	0.40
22	0.34
23	0.42
24	0.42
25	0.57
26	0.49
27	0.53
28	0.31
29	0.49
30	0.50
31	0.60
32	0.45
33	0.30
34	0.42
35	0.49
36	0.43
37	0.34
38	0.24
39	0.30
40	0.51
41	0.39
42	0.33
43	0.29
44	0.43
45	0.37
46	0.35
47	0.26
48	0.43
49	0.35
50	0.44
51	0.53
52	0.56
53	0.27
54	0.28
55	0.37
56	0.57
57	0.26
58	0.40
59	0.37
60	0.55

61	0.39
62	0.25
63	0.43
64	0.27
65	0.32
66	0.32
67	0.56
68	0.52
69	0.31
70	0.28
71	0.34
72	0.35
73	0.28
74	0.37
75	0.36
76	0.23
77	0.39
78	0.51
79	0.59
80	0.33
81	0.55
82	0.37
83	0.26
84	0.28
85	0.58
86	0.36
87	0.35
88	0.35
89	0.56
90	0.52
91	0.49
92	0.49
93	0.42
94	0.44
95	0.42
96	0.39
97	0.32
98	0.41
99	0.30